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# NEW PRODUCTION REACTOR ACQUISITION STRATEGY

## HEARING

BEFORE THE

SUBCOMMITTEE ON
STRATEGIC FORCES AND NUCLEAR DETERRENCE

OF THE

## COMMITTEE ON ARMED SERVICES
## UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

SECOND SESSION

OCTOBER 5, 1988

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# NEW PRODUCTION REACTOR ACQUISITION STRATEGY

WEDNESDAY, OCTOBER 5, 1988

U.S. SENATE,
SUBCOMMITTEE ON STRATEGIC FORCES
AND NUCLEAR DETERRENCE,
COMMITTEE ON ARMED SERVICES,
*Washington, DC.*

The committee met, pursuant to notice, at 10:20 a.m., in room SR-222, Russell Senate Office Building, Senator J. James Exon (chairman) presiding.

Present: Senators Exon, Thurmond, and Symms.

Staff present: Robert F. Bott, Sherri Wasserman Goodman, William E. Hoehn, Jr., Ronald P. Kelly, T. Kirk McConnell, and Michael J. McCord, professional staff members; and Mickie Jan Wise, staff assistant.

Also present: Jeffrey B. Subko, assistant to Senator Exon; Christopher E. Paine, assistant to Senator Kennedy; Edward M. McGaffigan, Jr., assistant to Senator Bingaman; Donald A. Mitchell, assistant to Senator Glenn; Terrence M. Lynch, assistant to Senator Shelby, and James M. Bodner, assistant to Senator Cohen.

## OPENING STATEMENT OF SENATOR J. JAMES EXON, CHAIRMAN

Senator EXON. The subcommittee will please come to order. This morning the subcommittee meets to review the acquisition strategy of the new production reactor. This matter has become increasingly important, given the uncertainty surrounding the continued operation of the existing reactors. We are pleased to have the Deputy Secretary of Energy, Mr. Joseph Salgado, and his representatives here with us today.

In August the Secretary of Energy announced his preferred strategy for providing this Nation with an assured source of tritium for our nuclear deterrent forces.

He recommended proceeding on an urgent schedule to construct a heavy water reactor at the Savannah River Plant which can meet 100 percent of the expected tritium requirements. He has also recommended concurrent construction of a modular high temperature gas reactor which would be able to meet 50 percent of the tritium requirement.

I believe that the construction of the first new production reactor that meets the dual goals of safety and ability to provide required quantities of tritium is an urgent national priority, one, I might say, of our most important priorities.

As far back as 1980, both the Department of Defense and the Department of Energy recommended that a new production reactor "be on line by or before the early 1990s." In 1982 an independent advisory panel stated that, "An NPR should be constructed to assure an adequate supply of strategic materials for the 1990s and beyond."

It is now 1988 and we are just beginning, yet again, to embark on a course that will not provide us with a new production reactor for another 10 years. The National Academy of Sciences recently concluded that "The remaining useful life of existing production reactors is likely to be equal to or shorter than the time needed to authorize, fund, design, and build new facilities to produce special nuclear materials."

One of the issues before us today is whether DOE's recommended strategy is the one that will enable us to have at least one new production reactor operating as quickly as possible and in a safe, environmentally sound and cost-effective manner.

The budget for DOE's nuclear weapons complex is already severely strained. Recent estimates for modernization of aging plant and equipment throughout the complex for environmental restoration and for cleanup and waste disposal will run as high as $100 billion. The new production reactor needs to be considered as part of this overall plan for revitalization and cleaning up our defense nuclear complex. We need to carefully consider how the scarce resources of the future should best be used.

Another focus of today's hearing is the issues that remain to be addressed for the technologies selected for the new production reactor. In connection with this subject, I would like to submit for the record the statement of Dr. Lawrence T. Papay, Chairman of the Independent NPR Technology Assessment Panel. In their review they conclude, and I quote, "The most important factor in assuring safe and reliable production of nuclear materials is the maturity of the reactor and target technology."

[The prepared statement of Mr. Papay follows:]

PREPARED STATEMENT OF DR. LAWRENCE T. PAPAY, SENIOR VICE PRESIDENT, SOUTHERN CALIFORNIA EDISON CO.

Good Morning. I am Larry Papay, from the Southern California Edison Company. I am speaking to you today in my role as a member of the DOE Energy Research Advisory Board (ERAB) and, in particular, as past Chairman of its Panel that prepared the Board's Assessment of reactor technologies for new production reactor (NPR) capacity.

The Board was asked by the Secretary, in a letter on January 7, 1988, to review and assess the Department's proposed selection criteria for the NPR; the adequacy of each of the four technologies to meet the criteria; and schedule and technical risks, benefits and costs in implementing a NPR program with each technology. The letter requested a response by June 1, 1988, but the Secretary later agreed to a one-month extension of the response date because of the large amount of work involved and the limited time in which to do it.

The four reactor technologies to be considered were identified by the Department to be the Heavy Water Reactor (HWR), the High Temperature Gas-Cooled Reactor (GTGR), the Light Water Reactor (LWR), and the Liquid Metal Reactor (LMR). Production of tritium is the primary mission of the NPR.

The Board formed a Panel of 19 experts to help perform the assessment. The Panel provided technical background and current information for use by the ERAB in completing its assessment. The Panel included individuals with wide experience in the management of reactor facilities, nuclear engineering, engineering of large energy systems, safety and environmental concerns, and physics.

The Panel was divided into four subpanels, each concentrating on one of the four technologies. Each Subpanel chairman was assisted by one or two additional technical experts to help evaluate the technical information that was presented by proponents for each of the reactor types and assist in drafting the reports. The DOE also provided a technical and administrative support team of DOE and contractor staff to help organize, assimilate, and evaluate in-depth the information.

The first ERAB meeting on this subject was held on February 10 and 11, 1988. The Board approved an interim report to the Secretary at that meeting, on the assessment of the Department's selection criteria. The interim report was submitted, as requested, on March 1, 1988. During preparation of the Interim Report, the Board requested clarification from the Secretary on the extent to which it should evaluate duality features; that is, diversity of reactor technologies and more than one site. The Secretary responded with a letter on April 28, 1988 that specifically requested the ERAB to include duality issues in its assessment of the reactor technologies.

The Panel had several meetings during March and April to receive information from proponents of the various technologies and to examine classified material related to production technologies. The ERAB met for three days on June 13–15, 1988 to formulate its findings and to prepare its final report to the Secretary. The final report was submitted on July 1, 1988.

The ERAB does not make recommendations in this report and does not rank or directly compare the four technologies. We were not asked to do so. Rather, we assessed each of the technologies according to the criteria and considered risks and benefits. The report presents fourteen findings and a table of strengths and weaknesses of each technology when used for a NPR.

It may be useful to briefly state some of the findings of the ERAB in each of the areas of the Secretary's charge:

*Criteria*

The Board emphasized that the ability to meet safety and environmental requirements among the Department's suggested set of criteria, should be of equal importance to the criterion on the ability to produce goal quantities of tritium on a timely schedule, and that these two should be the primary criteria.

*Adequacy of Technologies to Meet the Criteria*

The Panel realized early in March that the target technology is the key technical feature that discriminates between the four reactor technologies. The target technology refers to the lithium targets that are inserted into the reactor to absorb neutrons and produce tritium. The HWR has a fully developed and proven target technology as a result of our long experience at the Savannah River Plant, while the other reactor types require further research, development, or qualification testing. Uncertainties in the schedule and cost of the NPR that would arise from the use of a technology that requires further development and testing was a major concern of the Board, and outweighed other schedule and cost concerns such as those due to the safety review process.

The Board believes that the design features of the NPR should take full advantage of the results of reactor safety research and operational experience to date, and that the safety performance of the NPR should be at least equivalent to that of the best of present commercial power reactors.

Each of the technologies are expected to meet the requirements of a safety review process, although some technologies will take more time to obtain the necessary data and analysis capability than others. None of the reactor technologies that have already had some safety review, have had the target technology included in the review process. The Board urges the Department, in consultation with independent safety overview bodies, to establish the review process for the NPR project without delay.

The schedule and cost data that was presented to the ERAB and its Panel was judged to be preliminary, and useful only for qualitative comparisons. The information was prepared originally for other purposes and on a different basis in each case. In regard to schedule and cost, the report notes that successful development, design, construction, and startup of a NPR requires a continued commitment from both the Executive Branch and the Congress over many years.

The Board considered the possibility of completion of the WNP–1 light water power reactor on the Hanford site, and conversion to tritium production as a NPR. We treated this a bit separately from our assessment of the basic technologies because it is a specific piece of hardware. We recognized that it was an important consideration because it offers the possibility of a shorter schedule and lower initial costs than that of a new reactor of any type. We were concerned, however, about

uncertainties of the schedule associated with the WNP-1 because of the need to develop the target technology, the time needed to implement the legal processes to acquire the reactor, and the uncertainty of obtaining public acceptance of conversion of a commercial reactor to defense applications.

*Risks Benefits and Costs*

The most important factor in assuring safe and reliable production of nuclear materials is the maturity of the reactor and target technology. The HWR has an advantage in this respect.

The use of multiple smaller reactors of a given type offer advantages of protection against loss of all capacity, flexibility of operation and production, and increased potential for the use of passive safety features, but at some added cost. The ERAB believes that the use of multiple, smaller reactors should be considered for any technology that is selected.

The use of multiple reactors with diverse technologies and located at separate sites offers additional benefits of providing higher production assurance, reduced uncertainty in the schedule, and less technical risk, but again at higher cost. A single unit NPR is the lowest initial cost option, but carries the operational risk of unexpected loss of all capacity for an extended period. If a single-technology option were selected, it would be prudent to develop target technologies for other reactor types to provide for future contingencies.

The most significant effect on overall cost of the NPR would come from the revenue gained by the sale of energy produced by the NPR. Unfortunately, the amount of this revenue cannot be determined accurately at this time. The sale of steam to a utility for conversion to electricity is preferred to the generation of power by the NPR because defense material production would be better separated from electric power production, the initial investment would be reduced, and external institutional interactions with regulatory agencies and utility customers would be reduced. The revenue to be gained can only be determined accurately by negotiations with electric utilities at the potential sites.

I have rather briefly summarized some of the issues that were important in the ERAB discussions on the NPR. I would be happy to try to answer questions on these or any other aspects of the ERAB NPR report. Thank you.

Senator EXON. The final, and perhaps most important, issue we need to address today is DOE's performance to date, a poor performance, in managing the Nation's defense nuclear facilities. This has been most recently documented by the Savannah River Plant, but is true throughout the DOE defense complex. From Idaho to South Carolina, DOE has been justly criticized for lax safety practices. This is one of the reasons the Armed Services Committee worked hard this year to establish an independent safety board to oversee DOE's defense nuclear facilities. We believe this is an important piece of legislation that can help to improve some of the past practices.

But that alone is not enough. DOE itself must play a more active role in improving the operational safety practices of line management and in ensuring that the Department, not just the contractor, establishes and enforces the safety standards under which these facilities are operated. If safety practices are not rapidly improved, it will be difficult, if not impossible, to gain public confidence in the operation of these new facilities.

There has been much confusion lately over how much DOE and its predecessor, the Atomic Energy Commission, knew about reactor incidents at the Savannah River Plant, and how much control was ceded to the contractor. The Department's responses in this regard are not reassuring. I would like to ask the Department to provide the committee with a report by the end of the calendar year that, one, responds to the issues raised both by recent events and by past practices and, two, offers a plan for ensuring that should such events ever recur, the appropriate safety practices are

followed. Mr. Secretary, I hope that you can provide us with such a report by the end of this year.

Before we begin, I would like to turn to my dedicated colleague and coworker in this area, the ranking member of the subcommittee, Senator Strom Thurmond of South Carolina, for any opening remarks.

Senator THURMOND. Thank you, Mr. Chairman.

Once again, Mr. Chairman, you are to be congratulated for your dedication to the full range of nuclear weapons research and production issues that come under the purview of this subcommittee. It was through your leadership that the subject we address this morning, the new production reactor, was taken up as a congressional initiative in last year's budget, and was fully supported in the authorization bill that became law last week.

I want to take this opportunity to welcome here this morning the Honorable Joseph F. Salgado, the Deputy Secretary of Energy, and Mr. Cochran, with the NPR project, and Mr. Troy Wade, of defense programs, and Mr. Ernest Baynard of safety.

Mr. Chairman, I would also like to commend the Department of Energy on its recent decision to locate the new production reactor at the Savannah River Plant. This decision, which was enthusiastically supported by all the communities in South Carolina and Georgia that surround the plant, will bring the newest and most advanced technology to SRP. In addition, Mr. Chairman, DOE has announced that Westinghouse Electric Corp. will serve as the new contractor for SRP. I am certain that Westinghouse will bring to this challenge an unwavering desire to operate this facility in the safest and most efficient manner possible. I have stressed these points in personal meetings with Mr. John Marous, the chairman of Westinghouse, and some of his other officials, and I am confident of his commitment to these goals.

Mr. Chairman, I also congratulate our witness, Deputy Secretary Salgado, for his role in developing the new production reactor acquisition strategy that will be described to the subcommittee this morning.

Mr. Chairman, as we begin our discussion today, let us keep in mind that the nuclear industry has undergone a tremendous evolution since its inception. Knowing that, I am the first to admit that the Savannah River Plant has experienced its share of mistakes, problems and misjudgments. Accepting that fact, our role today should not be so much to blame as it should be to understand fully and learn from the mistakes that have occurred. With this attitude, we can help avoid future problems and keep from repeating past mistakes.

Mr. Chairman, you and I were motivated to press for a new production reactor by our belief, which was supported by considerable testimony before this committee, that there was an urgent need to provide an assured supply of tritium. This urgency was derived, in part, from the uncertainty surrounding the continued operation of the existing reactors. This concern has been underscored by the permanent shutdown of the N reactor and by the series of problems that are besetting the Savannah River reactors.

I believe that the new production reactor acquisition should be guided by the dual objectives of safety and the ability to provide for

essential quantities of tritium on an urgent basis. It is with those two objectives in mind that I address you, Mr. Secretary. I refer to the Department's handling of allegations about the management of the nuclear weapons complex over the past 30 years and what has been portrayed in the press as a preference for secrecy over safety.

Mr. Secretary, much of the focus of recent revelations has been on the Savannah River Plant, and you know how I feel about the absolute requirement for safe operation as a first priority. Mistakes have been made over more than 30 years and certainly appear to have been made in the recent restarting operation of the P reactor. However, the Department should not step away from a 30-year safe operation record at SRP, nor should we only focus on measuring the environmental record of the past with the standards of the present.

Mr. Secretary, I believe you have a safe operation at Savannah River, and I have every reason to believe that all the other defense program facilities are being run with safety as the paramount consideration. Clearly, there is room for improvement, including the imperative that the Department of Energy demand full disclosure and cooperation from the operators of all nuclear facilities.

The Department's public statement that reports of serious reactor incidents never made their way to Washington is not reassuring in this regard. I found this admission surprising since this committee in investigating allegations of a 1955 reactor incident during 1986, made note of one of the reactor incidents that has now become news. Moreover, the report recommended that internal DOE operating documents that were not classified be made available to the public. Mr. Chairman, I ask unanimous consent that the report referred to be incorporated in the record.

Senator EXON. Without objection, that is so ordered.

[The information referred to follows:]

U.S. SENATE,
COMMITTEE ON ARMED SERVICES,
*Washington, DC, July 22, 1986.*

HON. BARRY GOLDWATER,
*Chairman, Committee on Armed Services,*
*U.S. Senate, Washington, DC.*

DEAR MR. CHAIRMAN: Over the years, there have been recurring allegations of a radiation leak from an unreported nuclear reactor accident at the Savannah River Plant, which is part of the Department of Energy's Weapons production complex. Most recently, an article by Bernd Franke and Robert Alvarez published in the 1985 AMBIO (Vol. 14 No. 2) cited Savannah River Plant Health Physics Survey Group data that documented a large surface contamination in the vicinity of the plant that was detected on March 14, 1955. Savannah River Plant officials at the time and subsequently have attributed this contamination to fallout from an above ground nuclear test at the Nevada Test Site that was deposited during local rain showers. Franke and Alvarez conclude that "in the absence of other evidence, an accidental release of radioactivity at SRP would be a more plausible explanation for the observed radioactivity in the plant vicinity."

In response to a request by Senator Strom Thurmond (R–S.C.), staff has conducted an independent investigation into the March 14, 1955 incident. The investigation has focused on the specific issue of whether or not there was an unreported accidental release of radiation from the Savannah River Plant on or about March 14, 1955. The investigation has included discussions with Department of Energy officials, past and present employees of E. I. du Pont de Nemours, Inc., the operator of the Savannah River Plant, and with Bernd Franke and Robert Alvarez, co-authors of the article that triggered the most recent interest in this subject. A crucial aspect of the investigation has been a thorough review of classified and unclassified records that were compiled during March 1955. These records, many of which have been recov-

ered from government archive facilities and were not previously available, included health protection records (radiation survey logs, air sample logs, etc.) and operating reports.

Staff believes that the circumstantial evidence presented by Franke and Alvarez is merely speculative, and more significantly, believes that documentary evidence from the period rebuts their allegation. There appears to be no reason to conclude that an unreported nuclear accident at the Savannah River Plant was responsible for the radiation levels detected on March 14, 1955. This conclusion follows from the findings that are summarized below, and are detailed in the attached report:

Fallout from the TEAPOT HORNET above ground nuclear test conducted at the Nevada Test Site on March 12, 1955 was carried eastward by upper level winds on several trajectories, one of which have placed fallout over the vicinity of the Savannah River Plant on March 14, 1955.

Notwithstanding the concentration of fallout in the vicinity of the reactor area, it is improbable that the deposition pattern, which covered an area both east and west of the Savannah River Plant in the period of about one half hour, was caused by a Savannah River source. The direction and velocity of the reported surface winds during the twelve hours preceding initial detection are inconsistent with theories of a Savannah River Plant activity as the source of the contamination. Moreover, continuous atmospheric monitoring at the time did not indicate a release of radioactivity from Savannah River Plant activities.

The radioactivity exhibited characteristics of weapons test fallout (heavy concentrations of non-volatile particulates accompanied by radioactive iodines) and a decay pattern that is consistent with approximately two day old weapons test fallout. Longer lived radionuclides, which should be expected from a reactor accident, were not detected.

The so-called "hot spot" that was detected in the vicinity of the Savannah River Plant was not unlike fallout deposited by precipitation that was measured in other parts of the country during the period of above ground nuclear testing.

There is no indication in the documents reviewed of any unusual activity at the Savannah River Plant on or about March 14, 1955. Classified and unclassified documents report normal reactor operations in the weeks both before and after March 14. Health protection records and other reports covering all the activities at the Savannah River Plant provide no indication that the radioactivity detected on March 14 came from a source other than the nuclear test that had occurred two days earlier in Nevada. If a Savannah River Plant activity was the source of the contamination, it could be reasonably expected that some indication of unusual operational activity would be reflected in one or more of the documents reviewed.

Considerable resources have been expended in answering questions and in retrieving the documents that have provided the primary basis for the findings in this report. Staff does not believe that further expenditure of government resources on this question is warranted. Staff also recommends that the unclassified record reviewed during this investigation, which constitutes the majority of the relevant source materials, be made available for public review.

Finally, staff notes with appreciation that this investigation has been facilitated by the complete cooperation of the Department of Energy, both at Headquarters in Washington, D.C. and at the Savannah River Plant, of du Pont employees, and of Messrs. Alvarez and Franke.

Very respectfully,

ROBERT F. BOTT,
*Professional Staff Member.*

Attachment.

# SENATE ARMED SERVICES STAFF STUDY ON THE SOURCE OF RADIOACTIVE FALLOUT DETECTED AT THE SAVANNAH RIVER PLANT ON MARCH 14, 1955

## BACKGROUND

In a letter to Senator Goldwater on May 5, 1986, Senator Strom Thurmond requested that the cognizant and properly cleared staff member of the Committee on Armed Services investigate allegations of an unreported nuclear reactor accident at the Savannah River Plant (SRP) on or about March 14, 1955 and prepare an unclassified report on this matter.

The allegations of a reactor accident at the Savannah River Plant stem from large area surface contamination, which was reported in environmental monitoring records prepared at the time by the SRP. These data were recently cited by Bernd Franke and Robert Alvarez in an article published in the 1985 Ambio (Vol. 14 No. 2). In their article, Franke and Alvarez observe that data to indicate that Savannah River activities were not responsible for the radioactivity were not publicly available. In the absence of other evidence, they conclude that an accidental release of radioactivity at SRP would be a more plausible explanation for the observed radioactivity in the plant vicinity than radioactive fallout from a nuclear test for the following reasons.

First, since the center of the contamination was located around reactors K, L and P, a release from these areas, deposited by rainfall after at least 12 hours of atmospheric dispersion, could be considered a likely source of the contamination. Second, the decay of the radiation is consistent with two day old fallout from a nuclear weapons test, but it is also consistent with reactor fuel products at about 100 hours after unloading from the reactor. And third, based on calculations cited in the article, the level of radioactivity deposited in the vicinity of SRP represented an extreme fallout situation relative to the total fission products created by the TEAPOT HORNET test, and to "hot spots" observed in other parts of the country following larger tests.

These circumstantial reasons to consider a reactor accident at SRP as a source of the radioactive contamination were repeated in the draft of an article by Franke and Alvarez provided to the Armed Services Committee. The draft also cites newspaper accounts of two former employees of E. I du Pont de Nemours who claim that a crane moving nuclear fuel rods from the K reactor into cooling ponds got stuck with the fuel rods exposed, causing the rods to overheat and release large quantities of radioactivity into the atmosphere.

Each of the issues raised by Franke and Alvarez will be addressed in this report.

## APPROACH

The focus of this investigation has been on the original documentation that was prepared on or about March 14, 1955 by Savannah River Plant personnel as a matter of routine procedure. In addition, supporting data, such as Department of Commerce Weather Bureau reports, and Nevada Test Site data, were also reviewed and considered.

Staff met with Department of Energy personnel from Headquarters in Washington, D.C. and from the Savannah River

Plant, and with representatives of E. I du Pont de Nemours Company on May 23, 1986. This meeting afforded the Department an opportunity to present its version of the events on or about March 14, 1955, and provided staff an opportunity to ask questions, and to request records, logs, reports, and other original documentation relevant to the events of March 14, 1955.

Staff travelled to the Savannah River Plant on July 2, 1986, to review the documentation that had been requested. Much of this information had been retrieved from General Services Administration government archives in Atlanta, Georgia. During the visit, staff had an opportunity to hear from and question Health Physics personnel from the Savannah River Plant, who had conducted their own independent review of the retrieved records in search of any indication that SRP was the source of the contamination. During this same visit, staff met with and questioned former SRP employees who were in positions of responsibility at the time of the incident.

On July 11, 1986, staff met with Robert Alvarez to insure a correct understanding of his views on the March 14, 1955 incident, and to question him on certain technical aspects of the circumstances that led him to a different conclusion than Savannah River Plant personnel. Bernd Franke was reached by phone in Germany on July 16, 1986 for a similar discussion.

## TEAPOT HORNET NUCLEAR TEST

On March 12, 1955, a fission device with a four kiloton yield, codenamed TEAPOT HORNET, was detonated on a tower at the Nevada Test Site. Weather Service Nuclear Test Support Group data from 1956 reported that the meteorological trajectories of this burst indicated that the debris were carried eastward and fanned out to cover most of the central and eastern United States.

Trajectory data (see Figure 1) for fallout from the test did not indicate passage over the Savannah River Plant on March 14, 1955, but rather indicated passage several hundred miles to the north. This does not discount the probability that fallout from the TEAPOT HORNET test was deposited on the SRP, since these trajectories were not based on high altitude sampling of air for radioactivity, and the atmospheric soundings did not indicate the width of dispersion in the trajectories.

There have been recent press reports quoting an official at the Nevada Test Site to the effect that radiation found in the Savannah River environs probably did not result from a nuclear weapons test in Nevada in 1955. This statement was apparently based on a prepared response to general press inquiries, and subsequently was formally retracted as being erroneous. Nevada Test Site officials agree with the conclusion that fallout from the HORNET Test was deposited at the Savannah River Plant by rainfall.

FIGURE 1. METEOROLOGICAL TRAJECTORIES FOR TEAPOT HORNET TEST

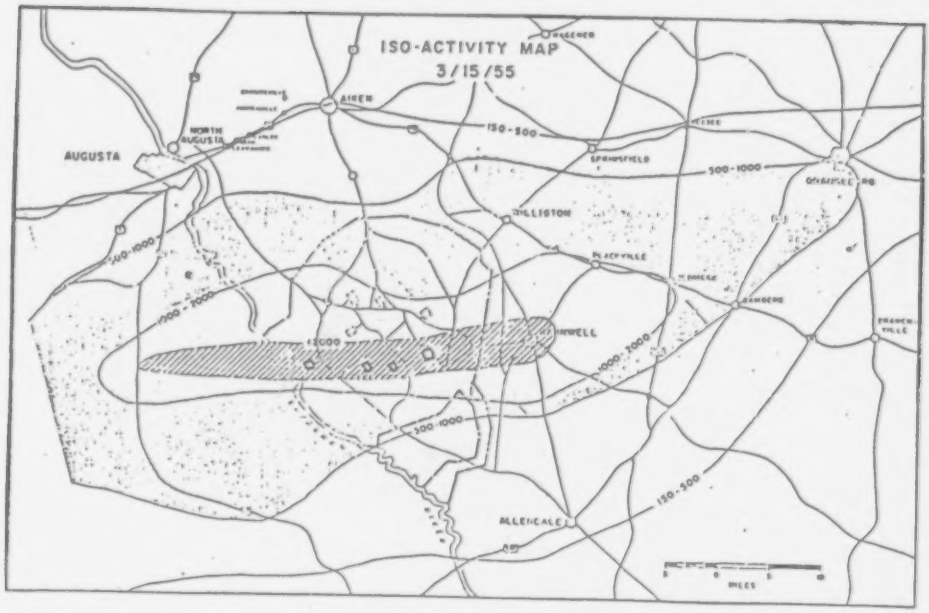
(Source: Radioactive Fallout in North America from Operation Teapot, February 1956.)

## FALLOUT DEPOSITION AT THE SAVANNAH RIVER PLANT

Fallout was deposited widely on the Savannah River Plant during rain showers that occurred during the mid-afternoon of March 14, 1955. The arrival of the fallout was detected by continuous air monitors, which had not detected abnormal atmospheric readings prior to the rainfall. This fact is significant because radioactivity from a Savannah River Plant source would have been detected in the atmosphere prior to being deposited on the ground by rainfall.

The fallout deposition pattern (see figure 2) ran generally from east to west, with the most significant radioactivity levels centered over the reactor areas. The location of Savannah River Plant facilities relative to the fallout pattern has been the principal rationale for the allegations of an unreported reactor accident. However, if a reactor were the source of the radioactivity, one would expect the reactor source to be at the apex of the pattern, and the fallout to exhibit a distribution from the point source oriented according to wind direction.

FIGURE 2. ISO-ACTIVITY MAP OF SAVANNAH RIVER PLANT




(Source: Semi-Annual Progress Report, Regional Monitoring Group, January-June 1955.)

Weather data available for March 14 does not support the theory of an instantaneous release ("puff") of radioactivity from a reactor just prior to the detection of fallout. Surface winds at the time were at about 10 mph from the north and northeast, which is at right angles to the deposition pattern. To create the pattern in Figure 2 in the half hour or so in which it was deposited, surface winds would have had to shift dramatically, and have been blowing in excess of 100 mph.

Neither the weather data, nor data from the continuously running air monitors, supports the theory forwarded by Franke and Alvarez that the deposition pattern may have resulted from steady state (continuous) contamination that had been dispersed in the atmosphere for at least twelve hours, and then deposited by the rainfall. Surface winds for the fifteen hour period preceding the detection of radioactivity were blowing from a northerly direction and do not account for the generally east-west deposition pattern centered over the Savannah River Plant.

There is apparently no disagreement that the fallout deposited at the Savannah River Plant on March 14, 1955, is consistent with the fission products and decay times associated with an atmospheric nuclear test occurring approximately two days earlier. Franke and Alvarez indicate that the decay of the contamination around SRP is also "consistent with activity to halogens (iodine and barium isotopes) from SRP reactor fuel at about 100 hours after the end of the chain-reaction...".

The conclusion that SRP reactor fuel was the source of the contamination is contradicted by the preponderance of nonvolatile particulate fallout accompanied by radioactive iodines, as reported in the Savannah River Plant Regional Monitoring Group

Semi-Annual Progress Report for January through June 1955. Such a conclusion is further contradicted by gamma analysis of evaporated rain water collected on March 14 which was prepared by the Savannah River Laboratory in March 1955. A memorandum reporting the analysis noted the presence of the radionuclides molybdenum-99 and neptunium-239. These are consistent with atmospheric weapons test fallout, and would not be released from a reactor except in the case of a major fuel meltdown, which would also release long lived components that were not detected in the fallout analyzed at the time.

The available evidence relating to the characterization of the contamination collected on March 14, 1955 points to fallout from an atmospheric nuclear test as the most probable cause of the contamination. Alternative sources, while not ruled out by the available evidence, are merely speculative in the absence of substantial other evidence of a major nuclear incident at the Savannah River Plant.

It is relevant to note that the one significant reactor incident at the Savannah River Plant, which occurred at the K-Reactor on November 9, 1970, closed the reactor down for cleanup operations for 108 days. This incident resulted when an antimony-beryllium source rod melted during discharge operations, releasing radioactivity to the reactor building process room. The confinement system prevented virtually all of the radiation from escaping to the atmosphere. This incident may have been incorrectly reported to the press by two unnamed Savannah River employees (whom staff was unable to reach during the investigation) as having occurred in 1955.

Franke and Alvarez claim that an unusually high concentration of fallout was deposited on the Savannah River Plant, thus making it unlikely that a distant test in Nevada was responsible. According to calculations cited in their paper, they translate the measured dose rate at one location at SRP into a fallout of 45 $uCi/m^2$, or about a hundred times higher than the maximum fallout (presumably dry fallout from surface air) observed from the center of the cloud in Kentucky. To conclude that the fallout at SRP was from a test, they argue that one would have to believe that 1.5% of the total fission products from the test were deposited at SRP. This percentage was contrasted with fallout from a previous test series where only 0.4% of the fission products were deposited over the whole United States the second day after the shots.

The Franke-Alvarez calculation of fallout does not agree with measurement data reported in the Regional Monitoring Group report previously cited that indicated that the measured surface deposition at the Savannah River Plant was about 0.9 $uCi/m^2$ (reported as .77[1 x $10^{-7}$ $c/ft^2$]), or about fifty times less than the deposition calculated by Alvarez and Franke. The actual deposition thus accounts for a much smaller percentage of the total fission products resulting from the TEAPOT HORNET test than does the calculated percentage -- and the actual percentage is in line with similar depositions of fallout in the same period.

During the above ground nuclear test series in the 1950s, there were a number of locations across the United States where so-called "hot spots" resulting from concentrations of fallout by precipitation were measured. Alvarez and Franke cited fallout in Troy, New York where the gamma dose following a test eleven times larger than TEAPOT HORNET was 0.4 mR/hr compared to a 0.3 mR/hr measurement at SRP, and alleged that this is another indication that the SRP fallout was unusual.

Examination of the source document for the Troy, New York measurement indicated that 0.4 mR/hr was a value taken to be representative of the gamma ray dosage 1.1 days after arrival. The same source indicates that the highest measurement was 6 mR/hr, taken on pavement near a drain spout 2.1 days after arrival. The SRP document that cited the 0.3 mR/hr measurement did not sufficiently describe the sample to determine whether a comparison with the representative 0.4 mR/hr dose rate, or the highest measured dose rate, or some other value for the Troy, New York fallout incident is more appropriate. Moreover, the usefulness of the SRP figure as a representative value is undermined by a summary statement in the report that indicated that "inconclusive results were obtained in the measurement of dose rate from the (March 14) fallout."

The Troy, New York measurements are thus not a compelling argument to question the TEAPOT HORNET test as the source of the contamination at the Savannah River Plant. To the contrary, the example of Troy, New York and other measured "hot spots," following rainout of fallout from nuclear testing, point to the reasonableness of testing related fallout as an explanation of the experience at the Savannah River Plant.

The circumstantial evidence cited in support of the thesis of an accidental release of radioactivity from the Savannah River Plant falls far short of proving that such an accident did occur. Nevertheless, the concentration of radioactive contamination at the Savannah River Plant is reason, in and of itself, to review further evidence to insure that activities at the plant were not responsible. The following section summarizes the documentary evidence relating to operations of the Savannah River Plant on or about March 14, 1955.

## SAVANNAH RIVER PLANT OPERATIONS - MARCH 1955

The staff study focussed on documentary evidence relating to the operations of the Savannah River Plant during March 1955 on the justifiable inference that an accident serious enough to result in the level of contamination reported on March 14 would have had consequences on plant operations. This inference is supported by the analysis of fission products, which suggested that only a major nuclear accident could provide an alternative explanation for the contamination. It is also supported by documentation relating to seventeen significant nuclear events that have occurred at the Savannah River Plant since 1957, including the November 9, 1970 source rod meltdown noted above.

At the request of staff, Savannah River Plant personnel provided relevant documents for the period in question, and organized these by areas of plant activity, that is, separations (F, H), reactors (R, L, P, R), and other (M, D). The majority of these documents can be characterized as health protection records, which were the responsibility of the Health Physics Department. These records include daily radiation survey logs, air sample logs, shift logs, Special Work Permits (required anytime personnel required entry into a radiation area to perform work), and weekly reports (for the reactor areas). Summary level SRP Reports were made available for the Manufacturing Division, Works Technical Department, and for radioactive waste releases.

Staff is unable to determine whether every relevant document was made available during this review. (Staff noted that the shift logs for the reactor areas were not available, having been destroyed years ago in accordance with prescribed destruction

schedules, and some log sheets for the period of interest were not available.) Based on the significant documentation that was available and reviewed by staff -- over eighty separate documents, many including multiple log entries -- there is no indication that operations at SRP were anything but normal for the period prior to, during, and after the detection of contamination on March 14, 1955.

The documentation supports the picture of an aggressive effort on the part of Health Physics personnel to determine the source of the contamination, notwithstanding the fact that there was a pervasive presumption that the contamination was related to fallout from a recent nuclear test in Nevada. Significantly, the operation of the reactors is documented in some detail, and there is no indication of an incident, or of abnormalities in operations such as a shutdown or fuel loading and unloading, that might have contributed to an incident. The various documents reviewed during this investigation are summarized in the following paragraphs.

Radiation Survey Logs. These unclassified log sheets document for the various areas, the surveys that were conducted for radioactivity. They indicated that contamination on and after March 14, 1955 was widespread over a large area on the site, but provided no evidence of an accident at SRP that would have resulted in the contamination. Every indication was of normal operations and activities that were somewhat inconvenienced by the presence of contamination on the shoes of workers, etc.

Air Sample Logs. Available air sample logs, primarily for F-area stacks, did not indicate any unusual activity. The logs do not constitute a complete record and should be considered inconclusive in the absence of other data.

Shift Logs. These unclassified narrative logs provided considerable insight into the actions taken (surveys, measurement, air and water samples) to determine the source and type of radioactivity involved in the contamination of March 14, as well as the reactions of SRP employees to the contamination. There was no indication in these logs of any variance from routine operations. As noted above, these logs were not available for the reactor areas.

Special Work Permits. These unclassified documents were available for all the operating areas at SRP during the period in question, and indicated no abnormal events or deviations from routine operations and activities. Had there been an occasion for workers to enter an area for cleanup operations of any sort, the Special Work Permits would have been issued, and would have reported the situation in considerable detail.

Weekly Reports. These detailed unclassified (For Official Use Only) documents were available for each of the reactor areas (K, L. P, R, and C) for four weekly time periods covering the month of March 1955. The format of these reports lends itself to detailing reactor operations, as well as significant events occurring during the period. In total, these reports provided persuasive documentary evidence that a reactor incident was not responsible for the contamination detected on March 14.

Staff took careful note of the documented operations of the K-Reactor in view of the reported testimony of two former employees that indicated that fuel rods, which overheated during movement due to a stuck crane, were responsible for the March 14, 1955 contamination. Staff found no indication of a planned or actual reactor shutdown, which would have been required for fuel

movement. Rather, as indicated in the following excerpts from the weekly reports during March 1955, documented K-reactor operations appear to be normal.

> February 28 - March 6: The (K) reactor was down for maintenance and instrument work until the afternoon of March 5. Initial criticality following the K-1 discharge was reached at this time. The highest power level reached during the week was 50% at noon on March 6.
>
> March 7 - March 13: The power level was increased on March 11, 1955 to 163%. One four hour reduction in power to 1% occurred during the week because of flow monitor difficulties.
>
> March 14 - March 20: The (K) reactor operated at 163.3% throughout the period except for one unscheduled shutdown on March 15th. The number one alternator started arcing to the degree that it was necessary to shutdown for three hours for correction.
>
> March 21 - March 27: The reactor operated at a power level of 163.3% for the period covered by this report.

Monthly Progress Reports. These detailed classified documents were available for March 1955 for the Manufacturing Division (for which a classified Production Supplement was also available) and for the Works Technical Department. These reports indicated no unusual activities in SRP operations that would account for the contamination detected on March 14, 1955.

Radioactive Waste Releases. This classified document dated September 1960 covered the period from startup through 1959. During this period, no stack releases were reported for the reactors other than normal tritium levels (from the moderator). F-area stack releases for the period January-June 1955 were reported and were not out of line with other periods reported.

## RECOMMENDATIONS

A considerable allocation of SRP and Department of Energy resources has been required to retrieve and organize the documents and other data required for this investigation. In the absence of any direct evidence to indicate that a Savannah River Plant facility or operation was responsible for the contamination detected on March 14, 1955, staff recommends that no government resources be allocated to pursue this issue further.

Circumstantial evidence has fueled the possibility of an unreported accident at the Savannah River Plant primarily because direct documentary evidence to the contrary has not been made available to the public. A large body of unclassified information has been available and reviewed during this investigation, and has formed the primary basis of the findings reported herein. Staff therefore recommends that unclassified documents that have been retrieved from the archives for purposes of this investigation be made available for review by the public.

Senator THURMOND. Mr. Secretary, it is important to the viability of the new production reactor that the public have confidence in the ability of the Department of Energy to operate it safely and to manage technically complex programs effectively. I would therefore suggest, as a matter of first and obviously urgent priority, that you take decisive steps to ensure confidence in the management and safe operation of the existing weapons production complex. I believe that the Nuclear Weapons Safety Board that was just established in law will complement the Department's action. This is an area in which the Department must take decisive action.

In the course of today's hearing this Senator will be interested not only in hearing the details of the NPR acquisition strategy, but just as importantly, how you plan to carry out the strategy. I was particularly interested in reading in the Secretary's prepared statement about the dedicated management team that has been formed for the NPR, and will have some questions about this and other aspects of executing the acquisition strategy.

In view of the concerns I expressed earlier, this Senator will have to be assured that the NPR approach will not sap all the talent that is required to restore confidence in the safety and management of the existing complex which I believe is a prerequisite to a successful NPR acquisition.

Before concluding, let me again commend DOE on its decision to locate the NPR at the Savannah River Plant. This decision demonstrates faith in a facility that has served our Nation's defense structure well for over 30 years. I will be working closely with DOE and the appropriate committees in Congress as we take the necessary steps to make the NPR a reality, and throughout that process I will be stressing safety at every turn. It is up to Congress, the Department of Energy, and the private entities charged with operating our nuclear energy facilities to cooperate fully with each other to ensure that these plants are as safe and efficient as possible. We owe that much to the communities involved, the defense structure, and the Nation as a whole.

Thank you, Mr. Chairman.

Senator EXON. Thank you very much, Senator Thurmond, and I want to publicly thank you once again and compliment you for the excellent job you have done for many, many years in this area and the open mindedness that you have shown during our deliberations on the matter at hand this morning.

I am now pleased to recognize Senator Symms.

Senator SYMMS. Mr. Chairman, I would first just like to say I would like to join with you in thanking Senator Thurmond for his long efforts, but I would also as a member of the minority like to thank you, Mr. Chairman, for your continued interest in the strategic problems that we have with this subcommittee and the activity that you have participated in this year, and I personally appreciate it.

And I also appreciate the fact, since I am not a member of this subcommittee that you have been kind enough to allow me to participate in the subcommittee because as many members know, the new production reactor is an issue that is very important to my State and many of my constituents and it is an issue I am very interested in.

For almost 8 years, Mr. Chairman, I have watched the Department of Energy wrestle with the issue of its nuclear materials production capability. In 1983 Idaho was named the preferred site for a new production reactor, but the decision was deferred early in 1985. This is one of the reasons I was so pleased with the Secretary of Energy's recommendation for a two-reactor strategy. Obviously, I am anxious to see the promise fulfilled for my home State.

But, I do think there is a bigger issue, and I did speak to that on the floor of the Senate yesterday. But I feel that the Secretary has dealt with this in a very courageous manner.

In the age and condition of our current production reactors because of that age, our nuclear deterrent is vulnerable to the possible disruption of nuclear materials. We are particularly dependent on tritium. As former Assistant Secretary of Defense Frank Gaffney wrote in a recent defense news article:

Unless the United States can reliably replace its constantly degrading tritium supplies, every single nuclear weapon in the U.S. stockpile could be rendered essentially unusable within a finite period of time.

All of us here are only too well aware of our dependency on the K and P reactors. It is appalling that there is no backup for these reactors.

Now, Secretary Herrington has made a proposal that will correct this dangerous situation, and I would like to commend him on the decision. His bold plan calls for two types of reactors of very different technologies at two sites of considerable distance from each other. This will provide us with the duality and diversity that is inherent in almost every aspect of our defense.

It is appropriate that one of these reactors will be an updated heavy water design at the Savannah River Plant, and I am sure that this new reactor will meet all the necessary safety reviews of the future, will impose on any nuclear facility, and I have confidence that it will be built to be a safe reactor. But I think it is also appropriate that the second high-temperature gas cool reactor is slated for the Idaho National Engineering Laboratory which has a long history of reactor testing and operating. The HTGR will have the potential to make steam for electricity as well as tritium.

Should the United States someday have an arms control agreement, this reactor could operate for power sales benefitting the economy of the Nation as a whole. The HTGR could revolutionize our civilian military power industry, our civilian nuclear power industry, and restore us to our original leadership role.

So, I think that as Mr. Gaffney called it, it is a two for one deal. I think it is a good deal for the Nation, it is a good deal for security, and it provides a direction for us to go with the new technology that could put us back in the forefront of nuclear power production, because these are safe, fail-safe reactors.

I only hope that all of us in Congress who support nuclear defense will see the wisdom of this plan and will support it. If we do not, I fear that those who oppose U.S. nuclear strength will take advantage of this pending crisis in our tritium production and distract us by making an issue of how and where this production

should be achieved. If they succeed in dividing us, they will win and the security of this Nation will lose.

And I think, Mr. Chairman, I thank you again for your generosity, and I think we both heard Senator Thurmond in public and in closed meetings tell all of us that have an issue that we are interested in, if we do not stand together, we will hang separately. And I think this is an issue that is very important.

I want to welcome all the witnesses that are here. It is interesting that Troy Wade is here, who did an excellent job of running the site at INEL for many years, and we were proud to have him in Idaho. His relief is in Senator McClure's office waiting to brief the two of us on another matter at 11 o'clock, so when I leave it will be for that reason. But I thank you again for your kindness.

Senator EXON. Thank you.

Senator SYMMS. And I welcome all of our witnesses.

Senator EXON. We are, of course, very glad to have you, and thank you for your statement and kind words.

Mr. Secretary, we want to welcome you here this morning. Thanks for coming over and bringing your experts in this area. We will proceed now with your statement which will be accepted in full for the record without objection at this time.

If you care to read us the full statement, that choice is up to you. If you care to summarize, then we will go to questions. I am pleased to recognize you, Mr. Secretary, at this time.

## STATEMENT OF JOSEPH SALGADO, DEPUTY SECRETARY OF ENERGY, U.S. DEPARTMENT OF ENERGY

Mr. SALGADO. Thank you, Mr. Chairman and good morning. I appreciate the opportunity to come before you again. I also want to thank you for your accommodation in the schedule today because of other conflicting appointments that we had.

For the record, I would like to indicate to my far left, to your far right, Mr. Chairman, is Mr. Ernie Baynard. He is the Assistant Secretary for Environment, Safety and Health; Mr. Troy Wade, the Acting Assistant Secretary for Defense Programs; and to my immediate right is Mr. Ron Cochran, who is the project director of the New Production Reactor Office.

I will summarize, if I could, Mr. Chairman, very briefly my statement.

Our acquisition strategy is simple, and it is straightforward. We must develop capacity on an urgent, and I stress urgent, schedule. We believe that our strategy is low-risk, and it is a cost-effective path to that ultimate goal.

It is the Department's position to build, and we need to build two new production reactor plants, a heavy water reactor at the Savannah River Plant near Aiken, SC, to produce 100 percent of our goal requirements of tritium, and a modular high-temperature gas cooled reactor at our Idaho Falls site to ultimately produce 50 percent of that requirement. In addition, we will continue with efforts to develop light water reactor technology to retain that option in the future.

The Energy Research Advisory Board was commissioned by Secretary Herrington to review the technologies being considered by

the Department for the new production reactor. It concluded that a multiple reactor strategy, with diverse technologies, was of optimum benefit for the Department because it provided high production assurance and minimized technical risk to the national security.

Two plants would reduce vulnerability to natural occurrences, unforeseen technical and regulatory issues, and institutional questions. These two plants would ultimately replace the three remaining reactors at Savannah River as well as the N reactor at Hanford, WA, which as you are well aware, Mr. Chairman, is in cold standby.

Our ability to maintain a credible nuclear deterrent depends upon our ability to bring these two new plants on line before the remaining life of the plant at Savannah River is exhausted. The heavy water reactor design was chosen as a primary plant because it is the most mature technology and has existing support facilities that would assure the shortest possible schedule to operation. Because of its low temperature, low-pressure design, and with new safety designs, it will provide inherent safety benefits. It also has the lowest cost of any of the candidate technologies that were considered.

Similarly, the modular high-temperature gas cooled reactor was considered to be the next most advanced design in terms of target technology and the capability of meeting the stringent safety goals that we have set for this particular project. Because of its modular design, we will be able to build the plant—ultimately four reactors—in increments.

In addition, this design allows the possibility in the long term of steam generation to offset the cost of operations. And, like the heavy water site, the use of the Idaho National Engineering Lab will allow use of the existing support base to facilitate materials production.

The cost of this program is substantial, but the recommended strategy is a low-cost, low-risk route to providing production on an urgent schedule. We cannot afford to experiment with national security. We cannot afford to put all of our eggs in the proverbial one basket, and we cannot afford to delay.

To implement this strategy we have created a new Office of New Production Reactors. That office is currently in place. It will answer directly to the chief operating officer of the Department who is currently me. It is being formed from the best talent the Department has to offer to assure the success of this particular program.

The program that we have discussed briefly is a product of a highly structured process mandated by Secretary John Herrington. We have relied on experts from outside government, through the Energy Research Advisory Board, to review presentations on technology by lending corporations in the nuclear field. We relied on senior DOE officials to evaluate our available sites for their ability to meet our criteria. We have consulted with other agencies to be sure that we have conducted a complete and total analysis. We are convinced that we have the best answer to a very difficult and critical question. We look forward to your support in achieving this strategy.

In conclusion, I would like to add, Mr. Chairman, that we will comply with your requests and submit to you the report that you so desired, and hopefully it will be before the end of December.

I would like to take one moment to comment on the situation with the P reactor. I would like to put it in the context of time. The time, obviously, is the fact that in 1985 Secretary Herrington consolidated all the environment, safety and health functions within the Department under one Assistant Secretary. That had not been done before. He gave that Assistant Secretary shutdown authority. We attempted then to integrate some of what we consider the modern practices of the commercial world to the DOE complex which, as you are well aware, has been aging over a long period of time and has gone through long periods of neglect.

After the Chernobyl incident, Secretary Herrington and we at the Department asked the National Academy of Sciences to come in and do a critical analysis of us, the Department of Energy. A critical analysis of our contractors, to give us a road map, a guideline, parameters, to tell us how can we do our job better, and where are our deficiencies We asked for that.

And that has been lost in a lot of newspaper articles and a lot of the criticism that is valid. But we asked for that critical analysis.

Mr. Chairman, you are right. They came back and they said one of the crucial things that you have to look at as a Department, aside from the technical aspects, is how you manage your contractors. They told us that in that report approximately a year ago.

They also gave us other recommendations. They said we should have a strong independent board inside the Department, and we should have an advisory board. We have strengthened the internal independence of ES&H within the Department, and we established an advisory board in the Department. The Congress has also given us a new advisory board from which we will benefit.

The National Academy said put site representatives on your sites that report directly to ES&H within the Department, independent of the programs, and we have done those things. But, unfortunately, in the last few months with the breakdown of communications in the restart of P reactor, we did not do our job as well as we should at managing. Information did not come to the Department in a timely fashion with the startup of that reactor. In fact, it was 36–48 hours before the Department was aware of it.

We will take steps to proceed to alleviate that problem. But I want to make sure that we put this in the context that the startup of P reactor—in retrospect and by analysis of all the external bodies as well as internal bodies—did not offer a safety risk either to the personnel there or personnel off site. In that sense it was not a critical incident. But in the sense that there was, again, a failure of DOE to manage the contractors or a failure of the contractors to communicate with DOE, it was a critical incident, and it was exactly what the National Academy had indicated that we as a Department should be looking to rectify.

I would like to put that in the record about the P reactor so that the record has some balance. Mr. Chairman, Senator Thurmond, Senator Symms, we welcome your questions on any and all issues.

[The prepared statement of Mr. Salgado follows:]

PREPARED STATEMENT OF JOSEPH SALGADO, DEPUTY SECRETARY OF ENERGY, U.S. DEPARTMENT OF ENERGY

Mr. Chairman and members of the committee, I am Joseph Salgado, Deputy Secretary of Energy, and I am pleased to be here to provide testimony regarding the Secretary's strategy for new production reactor capacity.

One of the principal missions of the Department of Energy is to provide nuclear materials to meet defense requirements. Future requirements cannot be met reliably with existing facilities. The Department's long-range plans for the production of nuclear materials involve the replacement of our existing production reactor capacity in a manner to assure reliable production of tritium and plutonium in quantities that will satisfy future defense needs.

The need for new production reactor capacity is driven by the need for assured supplies of tritium for our nuclear weapons. Without a continued supply of new tritium, the effectiveness of our overall nuclear deterrent capability deteriorates rapidly. Tritium is required for both new weapons and for replenishment of the stockpile, since approximately 5 percent of the total tritium inventory is lost each year through natural radioactive decay (12.3 year half-life). Due to this high rate of radioactive decay, tritium must be provided to the stockpile on a continuous basis. Nuclear reactors are the only proven, practical means for producing tritium.

Currently, three production reactors, located on the Savannah River Plant (SRP) site in South Carolina, produce nuclear materials for the Nation's defense requirements. These reactors were commissioned in 1954 and have experienced aging effects that have reduced their operational reliability. A fourth reactor at the SRP site, the C Reactor, was retired from service in January 1987 for causes related to aging. Additionally, the N Reactor, located at Richland (Hanford), Washington, was operated between 1964 and 1986, primarily for plutonium production. The N Reactor was shut down in January 1987 for safety upgrades and modifications, some of which are still underway. In February 1988, a decision was made to place N Reactor on cold standby.

In order to determine additional actions that should be taken, Secretary Herrington requested the National Academy of Sciences and the National Academy of Engineering (NAS/NAE) to study and report on the aging effects and safety concerns at the SRP reactors. In its report on "Safety Issues at the Defense Production Reactors," the NAS/NAE concluded, among other things, that the production reactors all display symptoms of acute aging and their remaining useful lives are likely to be equal to or shorter than the time needed to build new production facilities; and if the United States finds it necessary to have a reliable and safe production capability, then planning for new production reactor capacity should be accelerated. As a result of issues raised the current tritium production capacity has been reduced substantially and the urgency of our need for new production capacity has intensified.

After an intensive review of options for new production reactor capacity, the Secretary has decided on pursuing a multiple reactor strategy. This involves proceeding on an urgent schedule with construction of a heavy water reactor (HWR) at Savannah River designed to produce 100 percent of expected tritium requirements and concurrent preparation leading to the construction of a modular high temperature gas cooled reactor (MHTGR) at the Idaho National Engineering Laboratory (INEL) which can produce 50 percent of expected requirements.

The Department has conducted a careful and thorough examination of available reactor technologies and potential sites for the reactors in determining the best approach for providing new production capacity. On January 7, 1988, the Secretary of Energy asked the Energy Research Advisory Board (ERAB), a standing independent advisory committee to the Secretary, to conduct a review and assessment of the four reactor technologies being considered by the Department. The reactor technologies considered in the ERAB evaluation process were: (1) Heavy Water Reactor; (2) High-Temperature, Gas-Cooled Reactor; (3) Light Water Reactor; and (4) Liquid Metal Reactor. These candidate technologies were chosen on the basis of their high potential to meet production requirements. The initial action of the ERAB was to develop evaluation criteria. These criteria covered technical, safety and environmental, cost, schedule, industrial base and institutional acceptability considerations. An ERAB panel of 19 experts including individuals with extensive experience in the management of reactor facilities, nuclear engineering, engineering of large energy systems, safety and environmental concerns, and physics was convened. The panel evaluated proposals submitted by proponents of the four technologies.

On January 28, 1988, a Site Evaluation Team (SET) comprised of senior DOE staff was established and charged with developing criteria and evaluating candidate DOE sites for new production reactor capacity. The evaluation criteria were: experience

base, site support, facilities, environment, safety and health, transportation, cost and schedule. The SET found that all candidate sites were acceptable.

An intensive effort was made to assure that cost estimates for each technology were developed on a consistent basis and evaluated against identical criteria. The cost estimates were prepared by industrial proponents of the various technologies. To assure comparability and reasonableness of the estimates, the DOE cost estimating team developed guidelines for the preparation of cost estimates. In addition, DOE provided standard values to be used by the proponents for such items as construction labor rates, management and administrative labor rates, cost of fuel and target materials, value of byproduct steam or electric power, etc. The proponent cost estimates were prepared in accordance with these guidelines. They were reviewed and adjusted to reflect DOE assessments of the technology and development risks. Lastly, the contingencies added by DOE were developed through a comprehensive process incorporating the findings of independent cost, schedule and performance risk studies.

The Energy Systems Acquisition Advisory Board (ESAAB), composed of high level DOE managers, held a series of meetings from March 1988 through July 1988 to review information related to the designation of preferred technologies and sites. In particular, the ESAAB reviewed the technology evaluation criteria; the site evaluation criteria; the ERAB, SET, and cost evaluation reports; a report on the legal feasibility of acquiring WNP-1, a partially constructed commercial light water reactor on DOE's Hanford Site; and the Office of Defense Programs strategies for the acquisition of new production reactor capacity.

In the course of its deliberations, the Department engaged in consultations with the Department of Defense, the Office of Science and Technology Policy, the National Security Council, the Nuclear Weapons Council, and the Office of Management and Budget to obtain their views and recommendations regarding the acquisition strategy for replacement production capacity.

The processes used in the evaluation of technologies and sites have been objective and comprehensive. The criteria utilized were fair and agreed to by all involved review bodies.

Among the technologies, various strengths and weaknesses were identified. With regard to the mission of producing an assured supply of tritium on an urgent schedule in a safe and environmentally acceptable manner, the maturity of the technology and safety considerations received emphasis. The principle of duality was found to be important in providing the capability for an assured supply of tritium. Acquisition costs and schedules also were analyzed.

Consistent with ERAB findings, the Department believes the HWR to have the most mature technology for tritium production and the lowest schedule risk because of the existing facilities and past experience. The inherent safety benefits provided by the low temperature and low pressure of the HWR concept were important considerations in the Department's decision. Additionally, the HWR would have the lowest initial cost of any new plant constructed to produce goal quantities of tritium.

With regard to duality, the Department agrees with the ERAB conclusion that a multiple reactor strategy, with diverse technologies, would provide high production assurance, reduce uncertainties in the new production reactor schedule and minimize the technical risks to national security. With two plants located at different sites, production would be less vulnerable to a number of external events, such as changing institutional requirements and natural occurrences such as seismic events. Choosing two different technologies also would provide protection against unforeseen technical issues and greater adaptability to meet future regulatory requirements. In addition, two plants would provide significant flexibility in managing operations and maintenance, while maintaining tritium or plutonium production. The cost for two plants would be offset somewhat by utilizing a design capable of providing byproduct steam. This strategy is consistent with and integral to the Department's efforts to modernize the nuclear weapons production complex. The reactors which produce one of the most essential materials in our nuclear deterrent, tritium, must be replaced along with the modernization of equipment and facilities for weapons production.

The recommended strategy provides a low risk, cost-effective path to an assured tritium supply on an urgent schedule by planning for both the well-developed and demonstrated HWR technology and facilities while also addressing the need for a diverse reactor technology located at a second site to achieve the full benefit of duality. Following the HWR, the MHTGR has been judged by the ERAB to have the next most developed tritium target technology. Its aggressive pursuit will be characterized by a program encompassing key technological milestones. The tritium target

development and engineering R&D activities comprise the first milestones followed by the construction and operation of a single reactor module. After successful operation of the single reactor module for approximately one year, the three remaining reactor modules will be completed and the supporting infrastructure will be built. As a further contingency, work should continue on target development for a light water reactor and on solving the institutional issues associated with the acquisition of WNP-1.

The Department is taking steps now to proceed on an urgent basis with the necessary safety and environmental reviews, design and construction of a new HWR with a tritium production capacity of 100 percent goal quantity. Similarly, the Department is taking steps to proceed with the target and engineering development, safety and environmental review and design of MHTGR plant which will lead to construction of a 50 percent goal quantity tritium capacity MHTGR. Recently I established a dedicated program organization, the Office of New Production Reactors, with the mission to implement the Department's recommendation. This office will report directly to me as Chief Operating Officer and will be provided the staffing and charter required to execute this important mission.

The acquisition strategy for new production capacity will be reviewed under the National Environmental Policy Act (NEPA) process, which will be completed prior to a final decision. An important major NEPA process step was taken on September 16, 1988 with the issuance of a Notice of Intent to prepare an Environmental Impact Statement (EIS) on the proposed siting, construction, and operation of new production reactor capacity and related support facilities. Meetings will be conducted at many locations from mid-November through early-December to obtain public comments on the scope and content of the proposed EIS.

The HWR was proposed to be constructed at the Savannah River Plant site where the fuel and tritium target fabrication and recovery support facilities already exist for initial operations. The MHTGR was proposed to be constructed at the Idaho National Engineering Laboratory which is in the process of constructing state-of-the-art reprocessing capability and has conducted numerous reactor development programs.

The reactors will be designed to meet all modern environmental requirements and will be required to achieve a level of safety comparable to the best of current commercial reactors. Their design and construction will be closely scrutinized by the Secretary's Advisory Committee on Nuclear Facility Safety. It is anticipated that the emphasis placed on inherent safety and passive safety features will enable the expeditious and successful completion of the independent safety review. Both reactor designs will address all concerns raised in the 1987 report to DOE by the National Academy of Sciences on safety at DOE production reactors.

The process used in evaluating the technologies and sites has been objective and comprehensive. The recommendation to use two different reactor technologies at two different sites offers maximum protection against issues unique to one reactor type or site and provides significant flexibility in management and operation. In summary, the recommended strategy provides a low risk, cost-effective path to meeting the Department's mission to develop an assured production capacity on an urgent schedule. The continuing support and commitment of Congress is fundamental to achieving this strategy.

That concludes my prepared remarks and I would be pleased to respond to questions.

Senator EXON. Mr. Secretary, thank you very much. We will go to questions now. I would ask the staff to advise the Chair and the individual Senator when the allotted time has expired. We will follow the usual time constraints so we can cover as much ground as possible and have as many rounds as is necessary.

I just want to start out by saying that my concern is not where this facility is located as a first priority. My concern is primarily that our tritium needs are met. Tritium is a critical need for our national defense effort, and we have to have the facilities required for its production. I am also concerned, Mr. Secretary, with the gigantic obligation that we have to clean up our nuclear waste material from the production facilities, the costs of which have been estimated at maybe $100 billion or more, not only cleaning that up but what it is going to cost. So my greatest concern is how we are

going to fit all of that—cleanup, modernization, and safety enhancements—into the constraints of the budget.

How are we going to carry out those priorities, given the constraints of the budget? I do not think we should start out this very important process that should have been started a long time ago by assuming that we are going to have unlimited funds to do what has to be done. That will be a major problem and there should be a better understanding of that than there has been to date.

I ask you this question, Mr. Secretary. The Secretary's decision proposes that we build two new production reactors. As I understand it, the first NPR is expected to be able to meet 100 percent of the tritium required for the Nation's nuclear deterrent forces. The second reactor would provide a backup capability to meet up to 50 percent of the tritium requirements.

Would it thus be correct to say that the first reactor is urgently needed to meet the Nation's tritium requirements and that the second reactor is primarily a backup capacity which will provide diversity and duality, but is not as urgently needed in the future as the second facility?

Mr. SALGADO. Mr. Chairman, in the simple terms you would probably—I would agree with you—say duality and backup. But I think I have to put this in the context of—let me put it in the context, if I can, of the country and special nuclear materials in general.

As you are well aware, there are two special nuclear materials this country needs if it is to maintain a nuclear deterrent: One is tritium. The other is plutonium.

We have laid out a scenario for the next 20 years and the turn of the century as to where we believe this country should be with the capability to produce those two special nuclear materials. We have indicated that by the mid 1990s we think that SIS should be on line producing plutonium, and that gives us a limited supply of plutonium for 8 to 10 years if it is needed.

The next issue turns us to tritium, and as you are well aware, I think there is an assumption in my answer and that is that the Savannah River reactors will not or probably cannot be operating at the turn of the century. They are approximately 34 years old now, depending upon their commission dates. That would put them exceeding 40-some-odd years where in the commercial sector, 25 years is the approximate life expectancy of a reactor. So, I think we have to make that assumption, that we will not have any other reactors operating at the turn of the century.

Now, if we take that as an assumption in dealing with national security, then we have to say for our tritium needs alone, are we as a country and we as a nation willing to say that we will rest our entire tritium production capabilities on one reactor? And the reactor we have picked is a heavy water reactor at Savannah River.

And this has nothing to do with any concerns about the safety or the design, the engineering, the construction. The only issue that we have before us is should this country have that as its sole source of tritium moving into the next century.

And I think the answer then is to look at it, say that is not sufficient because if, in fact, there was an extraneous event, if, in fact, something unusual occurred, if, in fact, something unknown oc-

curred to that one reactor, where does that leave this country? That leaves this country with an inability to produce tritium, with an inability to purchase tritium, with an inability to replenish our stockpile. And what it really means then, Mr. Chairman, in my opinion, is that the nuclear deterrent in this country will start to degrade rapidly and, therefore, that the systems that we have in place are to become no longer as effective as they should.

And so, the point is that in a sense when we say 100 percent and 50 percent, that says well, that is a redundancy. It is, but at the same time we are talking about what this country—where this country should be at the turn of the century. To delay the second design and the off ramps that we have built into this process on the modular high-temperature gas reactor I think leaves us vulnerable at the turn of the century. It leaves us vulnerable to external events and to internal events and that reactor facility itself with the heavy water.

And so if I were saying and I was looking forward, I would say, yes, it is a dual capacity up to 50 percent, but it is absolutely necessary because this country has to be able to have at least two sources of tritium. We have to have that. Right now on the books we have three sources, but those are aging reactors.

So, Mr. Chairman, given the budget constraints that we are talking about, and I am sure we will get into it a little bit more, I do not look at this as something superfluous. It is not something the Department came to and said that well, we want to take care of everybody. Not at all.

We put it in the context of what our obligation is to this country at the turn of the century. And when you look at it in terms of tritium supply, I do not see how we can turn away and say that we can rest all of our nuclear deterrent on one reactor. And even if you delayed for 5 years, that would mean the second reactor would not come on for another 5 years beyond that, and that is too long a period of time.

And so it is the Department's feeling, Senator, that it is crucial, and it is imperative, this country has that option. It may never need it, but the country and the people of this country deserve the option of a nuclear deterrent.

And so that is a long answer to a brief question, but it is the belief of this Department. The two-reactor strategy was recommended by our external board and it is adopted by us as crucial to the national security of this country at the turn of the century.

Senator EXON. Well, Mr. Secretary, my time is up.

Senator, I will yield to you, but I do have a follow-up question that I am not sure you answered. The question is not whether we need two reactors or not, I agree with that we need two. But if this situation is as urgent as you say it is, and I think it is, then I wonder whether we can afford to build a second reactor before the first is operating. It is something like the family that does not have any transportation and they have got people going to work and they have got kids going to school and they have got groceries to pick up and they have got to see the doctor and they have got to do all of these important things, and obviously they need two automobiles or two means of transportation to do that, but they do not

have sufficient money for two cars. They have to make do with one and keep it running safely.

I would think that under a situation like that a family would procure one automobile forthwith. If they do not have the money now, certainly they will want to buy it next month. But they have got to have some transportation now.

What I am trying to get at is whether you are telling me for the record here this morning, then, given the fact that we have facilities now that are beyond the age when they were proposed and planned and engineered to produce tritium, and given the fact that we cannot get them, either one of them, in production before the turn of the century, it is your Department's firm determination that we should not give either one of these reactors any priority over the other, that we could ignore the need, that we can just assume that the Congress is going to come along and provide all the money for cleanup that we referred to earlier and they are going to provide all the money to move these two reactors along so that in essence sometime in the year 2000 or 2001 both of these reactors will come on line simultaneously?

Mr. SALGADO. If I may answer, Mr. Chairman, I am not sure that they would come on line simultaneously. The point I am trying to make is this; I do not think the country can afford not to move forward aggressively with the two-reactor strategy; that we have committed in our analysis that our first priority, if there is a first priority, is the heavy water reactor because of the mature technology, but it will also face some safety issues there in redesigning.

We have indicated that there are some technological milestones that have to be met with the modular high-temperature gas reactor before that reactor moves into construction area and construction processes. These deal with the engineering design and some of the other processes that are going, but, we have said that we need to move forward.

The question of dollars and cents is always a difficult question. I would do you a disservice if I did not say that the country cannot afford not to move forward with the two-reactor strategy. I just do not believe that we can afford not to.

Now, what that means and what it really means is, it means that the 050 account within DOE is insufficient to carry that forward. I readily admit that. And it is something that the executive branch has to deal with in determining what our priorities are in the 050 account, and has to be something that we have to then dialogue with the Hill and this committee on what the priorities are.

And the real question is that we are not, and I do not want anyone left with the assumption that somehow we are degrading the heavy water activity and the movement forward in that arena to go on in the other tangent with the modular high-temperature gas reactor. That is not the case.

Obviously there are different technologies and as you are well aware through the contracting business that we do, there are different laboratories as we evolve the analysis going forward on both of those. But the real point in time is the fact that I just do not think we can afford not to, and I think if we look at our priorities as a Department and we look at our priorities in the complex or in

the entire overall complex of defense, we cannot afford not to move forward with a two-reactor strategy.

Senator EXON. Well, just let me say that I appreciate your forthrightness in this issue. I am not sure yet that I can understand in laymen's terms really what you are saying.

Let me put it in the context that everybody can understand.

If it was decided that the building of two new aircraft carriers was critically important in the near-term future for the United States of America and if we decide to build one of them nuclear powered and the other one conventionally powered, but we had to get them out there as quickly as possible on line for the national defense of the United States of America, I would think we would be derelict in our duties if we did not make a determination that we would move ahead and give priority consideration to one of those carriers regardless of how they are powered to begin to meet the overall national security needs of the United States and then bring the other one along as quickly as we can.

You seem to be ignoring the fact that you are going to have to set some priorities as to which moves the fastest and which gets along the line first. I do not have to agree with that from what I know in your testimony thus far. I will pursue that further later, and with my apologies, I am pleased to yield to my friend from South Carolina.

Senator THURMOND. On that point, Mr. Salgado, as I understand, the Department of Energy has decided that the Savannah Right Plant is the first priority, is that correct?

Mr. SALGADO. Yes.

Senator THURMOND. Now, Mr. Secretary, Dr. Papay summarized ERAB's review of NPR reactor technologies in testimony prepared for this committee as follows: "A most important factor in assuring safe and reliable production of nuclear materials is the maturity of the reactor and target technology. Uncertainties in the schedule and cost of the NPR that would arise from the use of a technology that requires future development and testing was a major concern of the board and outweighed other schedule and cost concerns such as those due to the safety review process." Do you agree with these findings?

Mr. SALGADO. Yes.

Senator THURMOND. Mr. Secretary, you indicated that the inherent safety benefits provided by the low temperature and low pressure of the heavy water reactor concepts were important considerations in the Department's decision. Can you expand on these safety benefits and put them in perspective relative to existing facilities?

MR. SALGADO. I would ask Mr. Baynard to address it. I think that the old reactors by their low pressure and low temperature themselves gave the safety benefits. Obviously the new production reactors will incorporate many new safety features, and there may be some internal design changes such as flow. I would ask Mr. Baynard to give you an answer to that question in more detail.

Mr. BAYNARD. Senator Thurmond, essentially a low-pressure, low-temperature reactor just by its nature is more forgiving than a high-temperature, high-pressure reactor, and that has certainly been our experience.

Senator THURMOND. And, Mr. Secretary, has the Department established the procedures whereby the NPR would be reviewed by independent safety review bodies?

Mr. SALGADO. The exact procedures and interface have not been delineated, Senator. There is a commitment that obviously we will have independent bodies reviewing the design and the safety features on the ongoing process to ensure credibility of the construction of this NPR and to ensure its safety. Obviously we need to establish the Defense Nuclear Safety Board by nominating individuals for it so they may get their staffs together so we properly align the interface that will take place. Right now we are content in developing the interface between Mr. Ahearne, who is the chairman of the Secretary's independent advisory board, and those things will be taking place and we will be happy to advise the committee as they progress.

Senator THURMOND. Mr. Secretary, can you highlight for the committee the technical procedural or other challenges that lie ahead for the two technologies selected in your acquisition strategy?

Mr. SALGADO. I would ask Mr. Ron Cochran to address it because each of these technologies has certain benefits in the line of acceptability in various areas, so each has the benefits as well as some detrimental activities surrounding them.

Mr. COCHRAN. Thank you. With regard to the heavy water reactor, there is a strong experience base of technology for that reactor, and it also will build on light water reactor technology. Many of the components will be exactly the same.

The area in which we will probably have to do some development work, some research, is in the area of safety analysis. As has been pointed out, heavy water reactor technology has not gone through the complete modern safety analysis that we would expect for these new reactors. So, we will need to do that.

With regard to the high-temperature gas cooled reactors, we do not have the same base of operating experience. And, in that case, we feel that we will need to go through development of some of the major components, some of the key features testing of those components—for example, the bearings for the helium circulators were a problem in Fort St. Vrain. That is a design change that needs to be made and tested. So, there will be equipment tests that will be required in the development of the MHTGR.

Also, there will need to be design analysis for the safety approach. In that case much more of the safety analysis for that technology has already been accomplished, and so we will have to add to that. Those are the key features of what we will need to do in our developmental activity for those technologies.

Now, I would make one other point about the HTGR technology. We do need to confirm that the tritium target technology is adequate for meeting our production needs. We have good research information on that, but we need to confirm it in a production mode.

Senator THURMOND. Mr. Secretary, do you agree with the findings of the Glennan report that the principal attraction of the INEL site in Idaho is providing duality of sites in the production complex?

Mr. SALGADO. I am sorry, Senator, could I have that question again? I apologize.

Senator THURMOND. Yes. Do you agree with the findings of the Glennan report that the principal attraction of the INEL site in Idaho is providing duality of sites in the production complex?

Mr. SALGADO. Yes, I do believe that that was the underlying rationale at the time of the Glennan report for the MHTGR at INEL.

Senator THURMOND. By the way, Mr. Chairman, I ask unanimous consent that the 1982 Glennan report be inserted in the record.

Senator EXON. Without objection, so ordered.

[The material referred to follows:]

November 15, 1982

The Honorable Donald P. Hodel
Secretary
U.S. Department of Energy
Forrestal Building, Room 7A257
Washington, D.C. 20585

Dear Secretary Hodel:

I have pleasure in enclosing, for your review, the final report of the New Production Reactor (NPR) Concept and Site Selection Advisory Panel (CSSAP) appointed by Deputy Secretary W. Kenneth Davis on July 21, 1982. The "charter" for the Panel, dated July 7, 1982, included a statement of "Objectives and Scope of Activities" which is quoted below.

> "To provide the Department of Energy (DOE) with recommendations on a concept and site selection for an NPR, based on proposed reactor concepts and sites to be furnished to the CSSAP. The major objective of the NPR is the production of tritium and other products to support the maintenance of the Nation's nuclear weapons stockpile. The Panel will prepare a report evaluating and ranking the candidate reactor concepts and sites."

The Panel met as a formal body on three occasions at the Los Alamos National Laboratory--July 27 through 30, August 10 through 12, and September 13 through 15. Additionally, the entire Panel met in Washington, DC on November 1 and 2 to review and complete the enclosed report. Informal meetings involving two to five members of the Panel met on four occasions to clarify or amplify certain members' understanding of particular issues. One such meeting took place at Lawrence Livermore National Laboratory on Monday, August 9, and involved five members of the Panel interested in the SIS process.

The enclosed final report was approved unanimously by the full Panel on November 2 at their meeting in Washington on that date. I think it is worth my recalling that this subject--the choice of a reactor concept and of a site on which it should be located--has been studied on several earlier occasions within the DOE and on at least one recent occasion by a group called together by Dr. Keyworth, the President's Science Advisor, earlier this year. It is suggested, respectfully, that further studies will do little to increase the validity of the recommendations our Panel has made.

We recognize, of course, the proprietary interests of many of the companies and Congressional people whose constituencies may be involved in each of the concepts or sites dealt with by our Panel. I can only say to you that it is my sincere belief that we have dealt with these matters thoughtfully, even-handedly, and in a determined effort to give you recommendations which, in our considered opinion, will best serve the security interests of the United States.

Although six reactor concepts were suggested for our review, we took the liberty of adding a seventh--really a simplification of one we were asked to address. The added "up-front" costs required to provide an energy production capability gave us concern. Providing such a capability would further stress current budget planning and could lower the probability of NPR program approval. The extent to which revenues from the sale of steam will offset such additional costs is a question sensitive to future power demands that would warrant building the generating unit by the USG or by private industry and, of course, to the pricing for electrical power some 15 or more years down the road.

It is a pleasure to commend heartily the services provided to and for the Panel by the good people at Los Alamos, the Albuquerque Operations Office, and members of Mr. Roser's staff. Most of the briefings we heard were provided by members of the Los Alamos National Laboratory staff who, individually and collectively, were very effective in their presentations and most patient in responding to the variety of questions posed by members of the Panel. In particular, I would like to commend James F. Jackson, leader of the Energy Division, who spared no efforts to make certain that the Panel was well served by his associates. Additionally, Dr. Jackson was extremely helpful in the preparation of the final report and the several earlier drafts of the document. Finally, I want to say that the members of the Panel made a team that would be hard to equal in their individual fields of special knowledge and in their willingness to debate the various questions which came up from each member as we worked our way to this final report. Special recognition should be made of the contributions of W. J. Howard who served most effectively as Vice Chairman.

It has been a privilege and a pleasure for each of us to be of service in this endeavor.

Sincerely,

T. Keith Glennan
Chairman, NPR/CSSAP

# REPORT OF THE NEW PRODUCTION REACTOR CONCEPT AND SITE SELECTION ADVISORY PANEL NOVEMBER 15, 1982

## EXECUTIVE SUMMARY

The New Production Reactor Concept and Site Selection Advisory Panel has evaluated the adequacy of future supplies of strategic nuclear materials (tritium and plutonium) and has reviewed seven candidate reactor concepts and four candidate sites for a New Production Reactor (NPR). This report provides the Panel's evaluation and ranking of concepts and sites called for in its charter. The key Panel recommendations are the following:

- An NPR should be constructed to assure an adequate supply of strategic nuclear materials in the 1990's and beyond.

- The NPR must be an efficient tritium producer, but should also be capable of producing plutonium and other reactor products.

- The Zero-Electric-Power Heavy-Water Reactor (ZEPHWR) located at the Savannah River Site is the Panel's recommended NPR concept providing the greatest assurance of meeting production goals.

- A second choice to the ZEPHWR, if the sale of by-product steam is required, is the Low-Temperature Heavy-Water Reactor (LTHWR) at Savannah River or the Replacement N-Reactor (RNR) sited at Hanford. The LTHWR provides better assurance of meeting production goals than the RNR. If tritium production at a site other than Savannah River were considered essential, or if greater emphasis were placed on the future revenue from the sale of by-product steam, the N-Reactor could become the clear second choice, or even the first choice, for the NPR. In fact, the Panel notes that the RNR at Hanford would provide the DOE with the combined program benefits obtained from retaining duality of reactor products production and the sale of by-product steam, together with acceptable assurance of meeting production requirements over the specified design life for NPR.

- The Panel concludes, that for reasons set forth in the body of the report, the other four concepts--Light-Water Reactor (LWR), High-Temperature Gas-Cooled Reactor (HTGR), Liquid-Metal Fast-Breeder Reactor (LMFBR), and Washington Nuclear Project Number 4 (WNP-4)--fail to meet adequately the criteria established by the Panel.

  The Panel also concludes that the Savannah River Site should be used for heavy-water reactors and the Hanford Site for all other concepts.

In making the concept and site ranking and evaluations, the Panel has considered numerous criteria. The most important of these were assurance of meeting the production goal for the operation of an NPR. Other important criteria for evaluation of reactor concepts were (1) costs, (2) safety and environmental impacts, (3) sale of by-product steam, (4) use of up-to-date technology, and (5) nonproliferation and public acceptance concerns. In evaluating candidate sites, the Panel was most concerned with (1) providing assured availability of reactor products, (2) ensuring that the site has adequate manpower and facility support for an NPR, and (3) ensuring that the site is suitable in terms of safety, environment, public acceptance, and cost.

## STRATEGIC NUCLEAR MATERIALS SUPPLY AND DEMAND

Early in its deliberations, the Panel was given classified information relating to the present status of the Nation's supply of strategic nuclear materials and an estimate of the long-range demand for and supply of such materials. Members of the Panel came to the conclusion that the need for the study they had been asked to undertake was a valid one.

## SITE SELECTION

### SUMMARY AND CONCLUSIONS

The Panel examined the following four candidate sites specified by DOE for consideration:

--the Savannah River Site (SR) in South Carolina,
--the Hanford Site in Washington,
--the Idaho National Engineering Laboratory (INEL) in Idaho, and
--the Nevada Test Site (NTS) in Nevada.

The selection of the candidate sites was based on the requirement that the NPR be built on a Federal government reservation.

The Panel identified a number of problems with NTS as an NPR site and eliminated NTS from consideration prior to ranking the candidate sites. The principal problems that were identified for NTS were (1) probable conflicts with the US underground nuclear weapons test program, (2) safety questions concerning weapons-test-induced seismicity, (3) the lack of an assured supply of sufficient good-quality water for cooling, and (4) the lack of sufficient support infrastructure to construct and operate a large weapon-materials production reactor along with required fuel-cycle and target-processing facilities.

The remaining three candidate sites were ranked with regard to each of 11 criteria thought to be important for determining the suitability of each for construction of an NPR (see Table I). Except for concerns about concentration of production facilities on one site in the case of Savannah River, both the Hanford and Savannah River sites were found to be satisfactory for the purpose intended. For the LTHWR sited at Savannah River, some salable by-product steam would be produced although the revenue potential, if any, is small. The INEL site was found to be less suitable than Hanford and Savannah River primarily because it lacks experience with many of the facilities and technologies required for a strategic nuclear materials production site.

### CRITERIA AND RANKING

The three principal candidate sites, Savannah River, Hanford, and INEL, are ranked with regard to suitability for each of 11 main criteria in Table I. No relative weighting of the importance of these criteria is implied by the order of their listing. The main concerns leading to the relative rankings for each criterion are listed and discussed briefly in the following text.

Two principal assumptions have been made for the purpose of making the rankings. The first is that if the NPR is constructed at any site except Savannah River, a tritium recovery and processing facility will be required to be constructed at that site. Second, the existing facilities at the site chosen for the NPR will be used to support its fuel cycle, with upgrades, additions, and modifications to be made as required.

TABLE I

SITE SELECTION CRITERIA

(1) Water Supply
(2) Support Facilities
(3) On-Site Professional Support and Infrastructure
(4) Construction Labor Availability
(5) By-Product Steam Sales
(6) Waste Disposal
(7) Environment
(8) Transportation
(9) Costs
(10) Public Acceptance
(11) Duality of Sites

1. Water Supply

- o All sites have an adequate supply of high-quality water.
- o There are potential concerns about contamination of the aquifer at INEL by reinjection of cooling-tower blowdown.

Hanford and Savannah River are ranked essentially equal with regard to water supply. INEL is ranked slightly lower because of potential concerns about contamination of the aquifer.

2. Support Facilities

- o Savannah River has sufficient heavy water for a new production reactor and has complete support facilities for a heavy-water reactor fuel cycle.
- o Hanford has complete support facilities (except for tritium recovery) for the current N-Reactor fuel cycle.
- o INEL has highly enriched fuel-processing and waste-calcination facilities but does not have support facilities for NPR in the plutonium-production mode. Unless the planned expansion of their reprocessing facilities is funded, there will be competition between the naval reactor program and NPR with regard to fuel reprocessing.

Hanford and Savannah River are rated essentially as equal with regard to available support facilities, and with reasonable additions each site could support all reactor concepts. However, Savannah River is more suitable for the heavy-water concepts, whereas Hanford is more suitable for the RNR concept. Hanford and INEL both lack a tritium recovery and processing facility. INEL is ranked significantly lower for all concepts due to a lack of fuel fabrication, plutonium reprocessing, and other production support facilities.

3. On-Site Professional Support and Infrastructure

- o Savannah River and Hanford currently support large-scale programs for the production of strategic nuclear materials.
- o INEL has no history of special nuclear materials production.

Savannah River has a full complement of on-site professional support capability and is backed up by a single integrated designer, constructor, and operator. Hanford would need to supplement the existing professional complement at the site. INEL is ranked significantly lower on this criterion because they would need a substantial addition to the professional staff.

4. Construction Labor Availability

- o A large work force is available very near Hanford or Savannah River.
- o Labor stability has been excellent at both Savannah River and INEL. Hanford has experienced construction labor disruption in the past, but indications are that this situation is now satisfactory.
- o At INEL, the crafts requirements for an NPR exceed the availability within 50 miles and are a significant fraction of availability within 200 miles for a number of crafts.

Hanford and Savannah River are ranked essentially equal in terms of construction labor availability. INEL is ranked lower because of possible shortages in construction labor with resulting construction delays.

5. By-Product Steam Sales

- By-product steam sales can significantly reduce the unit cost for strategic nuclear materials production, and we assume there will be an adequate market for this steam beginning in the 1990's.
- INEL or Savannah River would need additional high-voltage transmission capability for distribution of NPR power.
- Hanford has a current system of substations and transmission lines as well as a current infrastructure to support the sale of significant quantities of by-product steam from an NPR. The Bonneville Power Administration provides a regional distribution network for wheeling of power from an NPR at Hanford. The precedent for by-product steam sales is established at Hanford.
- The utilities near INEL have volunteered an interest in utilizing the by-product steam for the generation of electricity.

Hanford is ranked the highest of the three sites for sales of by-product steam. INEL and Savannah River are ranked somewhat lower because the additional transmission capability required for electricity distribution makes the purchase of such energy less attractive.

6. Waste Disposal

- Each of the three sites has ongoing programs in waste management and disposal to support an NPR.
- Available on-site support waste-processing facilities will be useful in meeting an early 1990's target operation date for an NPR, but additional facilities will be required.

Construction funding for a waste-solidification facility at Savannah River is expected. There are no plans for a geologic-disposal facility at Savannah River or INEL. DOE has an active program to develop geologic waste disposal in basalt at Hanford. INEL has a facility to convert waste into a calcined product. Funding would be required for a facility to convert this into glass for ultimate disposal.

7. Environment

- Each of the three sites is generally suitable for an NPR from the standpoint of environmental effects.
- The NPR is expected to have low rates of radioactive emissions.

All three sites are ranked essentially equal with regard to environmental criteria.

8. Transportation

- INEL lacks barge access.
- Hanford may avoid off-site shipment of radioactive waste from reprocessing through the possible future establishment of a basalt waste repository.

Hanford and Savannah River are ranked as essentially equal with regard to this criterion. However, if complete waste solidification and a geologic repository are funded at Hanford, it would avoid off-site transportation of radioactive waste, and Hanford would be ranked slightly higher. The lack of barge access to INEL for construction results in a lower ranking for INEL.

9. Costs

- Construction labor rates are lower at Savannah River.
- Hanford and INEL would require a tritium recovery and processing facility for an NPR.
- Hanford may avoid off-site shipment of radioactive wastes.
- Most fuel-cycle facilities for support of an NPR are in place at Savannah River and Hanford (especially for a heavy-water reactor at Savannah River and an RNR at Hanford). New fuel-cycle facilities would be required at INEL.
- Poorer construction labor availability and barge access at INEL may increase costs relative to the other two sites.

Savannah River has lower construction costs.

10. Public Acceptance

- Each of the three sites enjoys a high degree of local public acceptance.
- Hanford and Savannah River have ongoing production missions that are well accepted, whereas INEL lacks a simila. production history.

All three sites are rated as being essentially equivalent in terms of public acceptance of an NPR.

11. Duality of Sites (The Desirability of Having More Than One Site in Operation to Produce Strategic Nuclear Materials)

- All of the current tritium production and most of the current plutonium production takes place at Savannah River.
- N-Reactor at Hanford will cease operation in the early to mid-1990's, at which time all the Nation's strategic nuclear materials would be produced at Savannah River.
- It is important that the US production of strategic nuclear materials not be disrupted by any local site-dependent factor or occurrence.

Hanford and INEL are ranked as most suitable for providing duality of sites in the production complex. Depending on the concept selected, the revenue from sale of by-product steam from the types of reactor that would be built at these sites could exceed the added costs of duality.

## SITE CONCLUSIONS

The Panel's conclusions on NRP sites are as follows.

(1) Either the Savannah River Site or the Hanford Site is considered suitable for an NPR.

(2) The Savannah River Site is recommended if a heavy-water reactor is to be built, whereas the Hanford Site is recommended for any of the others.

(3) The Idaho Site was judged to be less suitable because of not having a history of materials production and such additional factors as lack of barge access and concerns over local labor availability and on-site professional support.

(4) The question of site duality was considered by the Panel. Although site duality does offer advantages, the Panel is not aware of any DOE plans to provide this duality in other areas of the weapons-production complex. We do recognize that their very long lead times make the reactor and support facilities a pacing item if such a policy is adopted.

## CONCEPT SELECTION

### SUMMARY AND CONCLUSIONS

The Panel considered seven candidate reactor concepts for construction of the NPR.

--Low-Temperature Heavy-Water Reactor (LTHWR)
--Replacement N-Reactor (RNR)
--Light-Water Reactor (LWR)
--Liquid-Metal Fast-Breeder Reactor (LMFBR)
--High-Temperature Gas-Cooled Reactor (HTGR)
--Washington Nuclear Project Number 4 (WNP-4)
--Zero-Electric-Power Heavy-Water Reactor (ZEPHWR)

The first six candidates were specified by DOE after an extensive DOE-sponsored screening and evaluation process. The seventh was added to the list by the Panel because it believes the extensive successful experience with Savannah River reactors and the demonstrated capability of the site contractor (duPont) make the ZEPHWR reactor the highest confidence option for satisfying the overriding objective of producing needed strategic materials on a timely basis.

After evaluation of the concepts with regard to a number of important criteria, the Panel recommends the Zero-Electric-Power Heavy-Water Reactor (ZEPHWR) sited at Savannah River as providing the greatest assurance of meeting production goals. A second choice to the ZEPHWR, if the sale of by-product steam is required, is the Low-Temperature Heavy-Water Reactor (LTHWR) at Savannah River or the Replacement N-Reactor (RNR) sited at Hanford. If the sale of by-product steam is required, the LTHWR provides better assurance of meeting production goals than the RNR. If tritium production at a site other than Savannah River were considered essential, or if greater emphasis were placed on the future revenue from the sale of by-product steam, the N-Reactor could become the clear second choice, or even the first choice, for the NPR.

The remaining four concepts (LWR, HTGR, LMFBR, and WNP-4) are downrated for two reasons. The Panel considers that the lack of demonstrated tritium retention and recovery capability of proposed target assemblies makes these concepts' qualifications questionable. Furthermore, these four concepts could raise considerable worldwide concern that the US was developing technology to convert commercial reactors to weapon-materials production. The LWR is ranked fourth because of uncertainties such as fuel and target performance. The HTGR

is ranked fifth because the reactor concept has not been fully demonstrated, especially in the size being contemplated, and the technology for reprocessing irradiated fuel and targets is less fully developed. The remaining two concepts, the LMFBR and WNP-4, are found to be unsuitable for a variety of reasons including concerns about product assurance and successfully meeting an early 1990's startup schedule.

## CONCEPTS: DESCRIPTIONS, ADVANTAGES, AND DISADVANTAGES

A listing of some of the more pertinent advantages and disadvantages of each of the concepts as perceived by the Panel follows.

### 1. Zero-Electric-Power Heavy-Water Reactor (ZEPHWR) Sited at Savannah River

The ZEPHWR is a higher-power version of the existing heavy-water-cooled and moderated Savannah River Plant (SRP) production reactors.

Advantages

- Demonstrated constructability, operability, and reliability of heavy-water reactors and supporting systems for producing tritium and plutonium.
- Production-scale operations for fuel and target fabrication, fuel reprocessing, and tritium and plutonium separation in place and operational.
- Low temperature and pressure operation.
- Simplicity of design and operation (not complicated by commitments to produce and sell by-product steam).
- Complete life-cycle experience.
- Production-scale waste solidification is planned, and funding is expected.
- duPont is a single integrated designer, constructor, and operator with an outstanding record of competence, experience, depth, and reliability.

Disadvantages

- Scale-up on size of reactor and number of target assemblies required. This design effort is in the conceptual stage.
- New design of emergency-core-cooling system, tritium removal, and containment required.
- Highest annual operating costs of the concepts. (No sale of by-product steam to offset production costs.)
- Has not undergone updated safety review based on strict compliance with current safety standards.
- Concentration of production facilities at a single site.
- Interactions with existing operating reactors have not been fully investigated.

### 2. Low-Temperature Heavy-Water Reactor (LTHWR) Sited at Savannah River

The LTHWR is a vertical-pressure-tube reactor, cooled and moderated by heavy water. It is similar in concept to the existing Savannah River Plant (SRP) production reactors, except that pressure tubes will be added to allow for the higher temperatures required for power generation.

As in the other by-product steam-product concepts, the Panel assumes that either an investor- or government-owned electric power producer would be willing to purchase the by-product steam from the NPR at a price approaching its avoided costs and to provide the turbine-generator and interconnection facilities. The smaller amount of by-product steam available from LTHWR limits the potential revenue from steam sales for this concept.

Advantages

- o A small extrapolation from present Savannah River reactors with demonstrated constructability, operability, and reliability of reactor and supporting systems for producing tritium and plutonium.
- o Production-scale operations for fuel and target fabrication, fuel reprocessing, and tritium and plutonium separation in place and operational.
- o Low temperature and pressure operation.
- o Production-scale waste solidification planned, and funding is expected.
- o duPont is a single integrated designer, constructor, and operator with an outstanding record of competence, experience, depth, and reliability.

Disadvantages

- o Scale-up on size of reactor and number of target assemblies required. Design in conceptual stage.
- o As in subsequent concepts, design complicated by commitment to produce and sell by-product steam. (Addition of pressure-tube technology for the LTHWR.)
- o New design of emergency-core-cooling system, tritium removal, and containment required.
- o Lowest ranking of the power producers in life-cycle cost benefits.
- o Has not undergone updated safety review based on strict compliance with current safety standards.
- o Concentration of production facilities at a single site.
- o Interaction with existing operating reactors has not been fully investigated.

3. Replacement N-Reactor (RNR) Sited at Hanford

The RNR is a graphite-moderated water-cooled pressure-tube reactor that builds upon the experience of the existing N-Reactor.

Advantages

- o Small extrapolation from N-Reactor technology with some upgrading for graphite stability, refueling, and steam generators.
- o Demonstrated base of reliability, constructability, and operability for plutonium production.
- o Demonstrated coproduction of tritium and plutonium.

- A second-generation production reactor, since there is no scale-up in power level.
- Production-scale operation for fuel fabrication in place. Proven fuel components for plutonium production.
- Existing Purex fuel reprocessing for plutonium production is being reactivated.
- Existing operating contractor with excellent record and complete life-cycle experience with the N-Reactor and its fuel cycle.
- On-site capability in reactor design, reprocessing technology, and waste management.
- Possible future on-site geologic waste repository in basalt.
- Revenue from sale of by-product steam could more than offset the difference in costs compared with heavy-water reactor options.

Disadvantages

- Redesign of enriched fuel and tritium targets required. Slightly higher temperature than in the present N-Reactor may affect tritium containment.
- New design of refueling, steam generators, graphite, and containment required.
- Additional waste volume form redesigned fuel.
- New facilities for processing tritium targets required.
- New facilities for dissolving new fuel are required.
- Has not undergone updated safety review based on strict compliance with current safety standards.
- Because of the present infrastructure of many different organizations, requires an integrating contractor assignment for NPR similar to the duPont role for heavy-water reactors.

4. Light-Water Reactor (LWR)

The LWR is based on current commercial pressurized-light-water-reactor (PWR) technology, specifically the Westinghouse four-loop PWR. With the exception of core and targets, the LWR incorporates components and systems in the reactor and balance of plant identical to those in currently operating PWRs.

Advantages

- Design based on Westinghouse advanced pressurized-water-reactor technology except for fuel and targets. It represents a mature industry option which has design, construction, and operating expertise available. The basic LWR concept has undergone numerous safety reviews, but the redesign will need new safety reviews.
- Because design is based on current PWR technology, confidence can be placed in cost and schedule estimates. Except for the core and targets, designs are well advanced.

- Revenue from sale of by-product steam could more than offset the difference in costs compared with heavy-water reactor options.
- The LWR has been a reliable and economic producer of steam for electricity.

Disadvantages

- Potential worldwide concern over use of commercial nuclear technology to produce weapons material.
- Prompt negative temperature coefficient of reactivity of low-enrichment PWRs is greatly reduced.
- Proposed fuel will require some fabrication R&D.
- Startup date contingent on sequential steps of competitive bidding for a reactor design and selection of an integrating contractor.
- Insufficient evidence of tritium retention in target.
- If current target design is used, its low melting temperature increases probability of target redistribution in core-melt accident in this reactor type. If higher temperature target is used, performance of the escape barrier must still be demonstrated.
- New facilities required at Hanford for dissolving fuels.
- Risk of production being disrupted by response to public pressure to address issues raised in connection with commercial LWRs.
- Has not undergone a safety review with the core and targets required for tritium production.

5. High-Temperature Gas-Cooled Reactor (HTGR)

The HTGR is a helium-cooled graphite-moderated reactor that is based directly on designs proposed for commercial HTGR power plants.

Advantages

- Revenue from sale of by-product steam could more than offset the difference in costs compared with heavy-water reactor options.
- Driver fuel developed and demonstrated.
- Production-scale operation for fuel fabrication.
- General Atomic has made good progress in overcoming problem of tritium retention in high-temperature targets.
- Rapid heat transfer to core graphite provides slow core heating during transients.
- If located at Hanford, would benefit from partial use of Purex facility and from possible high-level waste geologic repository.
- If located at Idaho, would benefit from Idaho experience to be gained in reprocessing Rover graphite fuel and would benefit from partial use of reprocessing facility.

- NRC has approved highly enriched operation at Fort St. Vrain, but the redesign will require a complete safety review.

Disadvantages

- The NPR would be a significant scale-up and redesign from existing HTGR experience.
- There is not sufficient US construction and operating experience to provide a satisfactory basis for assuring constructability, operability, and reliability of production.
- Experience at Fort St. Vrain does not provide assurance that such a reactor can be built and operated reliably to meet production goals.
- Technology for fuel and target reprocessing has not been fully developed.
- Large volume of radioactive waste whether or not spent fuel is reprocessed for uranium recovery.
- New facilities for fuel and target reprocessing would be required.
- High front-end costs.
- Has not undergone safety review with targets for tritium production.

6. Liquid-Metal Fast-Breeder Reactor (LMFBR)

The LMFBR is a liquid-sodium-cooled pool-type reactor in which the entire primary system is contained in the reactor vessel.

Advantages

- High neutronic and thermal efficiency.
- Advances LMFBR technology for which there is a national commitment.
- Revenue from sale of by-product steam could more than offset the difference in costs compared with heavy-water reactor options.
- A large volume of subcooled sodium can provide substantial protection against evaporation of core coolant in an accident.
- Large laboratory and industrial infrastructure available to support development. Concept utilized in US at EBR II and FFTF.

Disadvantages

- Target technology not proven.
- Capital costs highest of all reactor concepts.
- Sodium-coolant technology less well demonstrated than water.
- Poor utilization of fast-neutron spectrum.

- o Significant scale-up and redesign from existing LMFBR experience.
- o Very unlikely to meet production goals by early 1990's.
- o Major extrapolation of existing US LMFBR technology.
- o Has not undergone safety review with new fuel and targets.

7. Washington Nuclear Project Number 4 (WNP-4)

WNP-4 is a Babcock and Wilcox pressurized-water-reactor (PWR) power plant located on the DOE Hanford Reservation. Although 24% complete with essentially all of the nuclear steam supply system designed and procured, the plant has been terminated by the Washington Public Power Supply System (WPPSS). Large components such as the reactor vessel, vessel head, core barrel, and steam generators are on site. The balance of the plant is virtually completely engineered, and construction is well under way on major structures such as the containment building, general-services building, turbine-generator building, and cooling towers. NRC licensing is continuing based on the twin WNP-1 unit. A total of $804 million has been spent to date.

Advantages

- o Design based on established commercial (Babcock and Wilcox) pressurized-water-reactor technology except for fuel, targets, and any special safety systems that might be required.
- o Partially completed plant (about 25% of construction and 88% of procurement).
- o Revenue from sale of by-product steam could more than offset the difference in costs compared with heavy-water reactor options.
- o Potential schedule and cost advantages.
- o Located at one of the desirable production sites.

Disadvantages

- o Less-than-goal production capability.
- o Public concern stemming from use of a commercial plant for weapon-materials production.
- o Uncertainty in legal and contractual issues could delay construction.
- o Specialized production-type fuel would require a reengineered safety system.
- o Storage of components already on site introduces concerns regarding quality control.
- o Prompt negative temperature coefficient of reactivity of low-enrichment PWRs is greatly reduced.
- o High waste volume from fuel.
- o Production may be interfered with because of public pressure to address issues raised in connection with commercial LWRs.
- o Has not undergone a safety review with the new core and targets required for tritium production.

CONCEPT EVALUATION CRITERIA

TABLE II

CRITERIA FOR REACTOR-CONCEPT EVALUATION

- Product Assurance Once Operational
  - --Status of target technology
  - --System operability, reliability, and maintainability
  - --System flexibility
  - --Level of production
  - --Amount of technological extrapolation
- Confidence in Meeting Early 1990's Startup Date
  - --Current design status
  - --Recent design, engineering, and construction experience
  - --Infrastructure to support design and construction
  - --Development status of major components
  - --Full-scale operation/demonstration
  - --Research and development requirements
- Initial Up-Front Costs
  - --Capital costs
  - --R&D costs
- Levelized Product Costs
  - --Confidence in capital and operating costs
  - --By-product steam sales
  - --Level of production
- Safety and Environmental Considerations
  - --Radiation exposures
  - --Effluent discharges
  - --Reactor safety
- Strategic/Institutional Issues
  - --Duality of reactor concepts and sites
  - --By-product steam production
  - --Up-to-date technology
  - --Advancement of nuclear technology
  - --Nonproliferation issues
  - --Public acceptance

The criteria used in evaluating the candidate-reactor concepts for an NPR are listed in the foregoing Table II and described briefly in this subsection. The criteria of product assurance and operation in the early 1990's are of principal importance. However, strategic and institutional issues are also given significant weight in making the concept recommendations.

1. Product Assurance Once Operational

Once the NPR is operational, it is essential that it produce goal quantities of tritium reliably to supply the US defense needs. The absolute level of reliable production for each concept is therefore of primary importance. A high level of production helps assure that tritium demand will be met in spite of unanticipated shutdowns or operational difficulties. Assurance or demonstration of operability, reliability, and maintainability provides additional confidence that production goals will be met.

For tritium production, it is important that a suitable lithium target be available in the near future, a target that produces sufficient tritium, retains the tritium while in the reactor and allows the tritium to be totally recovered in processing. While tritium production is the primary mission for an NPR, it is important that an NPR also be flexible by being capable of plutonium production or coproduction if necessary.

2. Confidence in Meeting Early 1990's Startup Date

The Panel feels that is important that an NPR be operational by the early 1990's. The confidence that this schedule can be met is strongly affected by a number of factors. These factors are generally related to applicable past and recent experience, program R&D needs, and the current design status of the candidate-reactor concepts.

Recent design, engineering, and construction experience with a reactor concept may lead to a more rapid construction schedule, as may the availability of a large organizational infrastructure to support construction of the concept reactor. Prior full-scale operation of a concept reactor for an extended period provides added confidence that significant problem areas will have been identified prior to construction. The status of the reactor design and the status of component development each affect the confidence in any projected construction schedule.

In addition to confidence in meeting the early 1990's start-up date, the above factors also affect other criteria. For example, cost contingencies must be increased for those concepts that are in only very preliminary design stages. Concepts lacking recent design, engineering, and construction experience may not conform to current standards no incorporate the most recent technology.

3. Up-Front Costs

The up-front costs for an NPR are the reactor capital costs and the incremental R&D costs needed to construct a concept reactor. The base program R&D cost has not been considered in this evaluation of candidate-reactor concepts. In general, the capital costs are much higher than the required incremental R&D costs.

Reactor concepts having particularly low capital costs have less budgetary impact, a positive attribute for achieving public and Congressional acceptance. Very high capital-cost concepts may prove to be unacceptable, particularly if the NPR program becomes controversial.

4. Levelized Product Costs

The levelized cost reflects all costs net of revenues over the life of the reactor and adjusted for the time-value of money. A major contributor to the levelized tritium costs are the capital costs, which are considered explicitly as a separate criterion due to their immediate impact on the government budget process. A contributor to estimated capital costs are contingencies arising from the uncertainties due to extrapolation of designs from existing experience and concerns related to construction difficulties.

In evaluating the NPR reactor concepts, the absolute level of production is important in that low production levels tend to result in higher relative levelized costs (although this effect can be reduced by lower capital costs). A major factor in the NPR levelized product costs for by-product steam-producing NPR concepts is the revenue stream arising from sale of by-product steam. Revenue from sale of by-product steam could more than offset the difference in costs compared with heavy-water reactor options.

5. Safety and Environmental Considerations

It is important that an NPR operate in a safe and environmentally responsible manner. The NPR must meet safety and environmental standards

comparable to those for commercial nuclear reactors. Radiation exposures and effluent discharges are to be kept as low as reasonably achievable. Concepts having inherent safety features or proven redundant engineered safety features have advantages under this criterion over those lacking such features.

6. Strategic and Institutional Issues

These issues comprise many different concerns that may or may not be interdependent. Many of them reflect on the acceptability of an NPR concept. The five principal strategic and institutional issues are described below.

a. Duality of Production Concept. Because a generic problem can develop with any reactor technology, some diversity of reactor design could be an advantage in the production complex. Without duality of concept, a major generic or regional problem cold threaten to shut down the entire production complex.

b. By-Product Steam Production. Use of by-product energy that would otherwise be dumped will contribute to national energy resources, minimize thermal discharges, and provide revenue to offset costs. The ability to sell by-product steam for electric power generation may also allow retention of production capability during periods of reduced tritium or plutonium demand. (This was the case with the N-Reactor.)

c. Up-to-Date Technology. In building an NPR, it seems appropriate to take advantage of the technology development that has occurred over the past few decades, much of it at taxpayers' expense. In addition, since an NPR will be used well into the next century, the risk of technical obsolescence should be minimized.

d. Advancement of Nuclear Technology. Depending on the concept selected, the development and construction of an NPR may make useful contributions to the advancement of nuclear technology and nuclear safety.

e. Nonproliferation Issues. A proposal to use commercial nuclear technologies to produce weapon materials may raise grave concerns about nonproliferation.

## CONCEPT CONCLUSIONS

The Panel's conclusions on NPR concepts are summarized below:

- The Zero-Electric-Power Heavy-Water Reactor (ZEPHWR) located at the Savannah River Site is the Panel's recommended NPR concept providing the greatest assurance of meeting production goals.

- A second choice to the ZEPHWR, if sale of by-product steam is required, is the Low-Temperature Heavy-Water Reactor (LTHWR) at Savannah River or the Replacement N-Reactor (RNR) at Hanford. The LTHWR provides better assurance of meeting production goals than the RNR. If tritium production at a site other than Savannah River were considered essential, or if greater emphasis were placed on the future income from the sale of by-product steam, the N-Reactor would become the clear second choice, or even the first choice, for the NPR. In fact, the Panel notes that the RNR at Hanford would provide the DOE the combined program benefits obtained from retaining duality of reactor products production and the sale of by-product steam, together with acceptable assurance of meeting production requirements over the specified design life for NPR.

- The LWR is ranked fourth. The LWR and the following three concepts all suffer from proliferation and tritium-target concerns.

- The HTGR is ranked fifth because the reactor concept has not been fully demonstrated, especially in the size being contemplated, and the technology for reprocessing irradiated fuel and targets is less fully developed.

- The LMFBR is ranked sixth, in part because its development is less advanced than the other concepts.

- The WNP-4 reactor is ranked last, primarily because of retrofitting problems and the potential for adverse public perception of converting a plant designed for commercial production of electricity to production of weapons material.

The ZEPHAR sited at Savannah River and designed, constructed, and operated under duPont supervision and management is the concept most likely to provide the required amount of tritium by the early 1990's. The design of this system represents the least departure from proven technology, and the availability of a contractor of such proven competence and experience as duPont provides the greatest assurance that production goals will be met at predictable costs.

If production of electricity along with tritium is essential, the Low Temperature Heavy-Water Reactor (LTHAR) sited at Savannah River and designed, constructed, and operated under duPont supervision and management is the concept regarded as most likely to meet production goals by the early 1990's primarily because of the availability of duPont as the integrating contractor for NPR.

If production of tritium at a site other than Savannah River or an amount of by-product steam greater than available from a LTHWR is considered essential, the Replacement N-Reactor (RNR) sited at Hanford is the concept considered most likely to meet production goals by the early 1990's. If greater emphasis than the Panel's were placed on the future income from the sale of by-product steam, or if tritium production at a site other than Savannah River is deemed essential, the RNR could become a clear second choice, or even first choice for the NPR. The reactor design is a substantial improvement over the present H-Reactor, and like the heavy-water reactors, is a minimal departure from proven technology. The fuel and target designs are different but have been demonstrated by operation on a respectable scale. Contractors are available at Hanford with experience in running this type of reactor and carrying out the fuel-cycle operations it requires.

An LWR used as a tritium producer would require some development of cermet fuels and considerable target exploration to choose a proven target. Use of LWR technology for US weapon production could be interpreted as leading the way to weapon-material application of power reactors around the world--a proliferation consideration of major implications. There is also a risk of production being disrupted by response to public pressure to address issues raised in connection with commercial LWRs.

Any HTGR installation would require considerable scale-up to reach NPR production quantities, and US experience at Fort St. Vrain fails to provide assurance that the US can build and operate a HTGR-NPR reliably enough to meet production goals. High front-end costs, considerable remaining technology development, and schedule concerns for an NPR lead to this ranking for the HTGR as a production reactor.

Neither the LMFBR nor WNP-4 provide confidence that tritium production requirements could be met by the early 1990's. The LMFBR's high capital costs, substantial target uncertainties, and large required plutonium inventory results in its low position in the ranking. The inability to meet goal-production quantities and the potential for numerous institutional problems leads to a recommendation against the WNP-4 concept.

The Panel considered the advantages that could accrue from selling by-product steam to an electrical power system. These advantages could include protection against inflation, the offsetting of operating costs, and justification for continuing facility operation during periods of low materials demand. The Panel recognizes that the magnitude of power-generating revenues is uncertain and will be influenced by demand and kWh-pricing variations and production reactor operation.

The likelihood of a reactor-products-demand-slump seems remote. In the 1960's the N-Reactor, but for its role as a power generator might have been closed. Power generation can have negative aspects beyond the higher up-front costs. These include possible licensing exposures, added interface and infrastructure requirements, and recognition of the US sentiment to separate weapon-materials production from commercial power.

In general, the Panel felt that the available cost and schedule predictions are also uncertain, especially with respect to absolute and even to relative costs. This led the Panel to apply its own judgment in the area of expected costs.

Members of the Panel would like to call to the attention of those responsible for these matters the fact that, if one NPR is on stream in the early '90's the DOE will have provided, in fact, only for the replacement of a portion of the production capacity of the existing Savannah River production reactors, all of which will then be approaching 40 years in service. Since the principal product expected to be produced in the NPR is a relatively short-lived material, it appears to us that the exercise we have just completed should be repeated at intervals to insure a continuing availability of modern production facilities so long as these materials are forecast to be needed. A continuing moderate level of effort in R&D will be justified to insure that production reactors authorized for construction in later years will continue to be as up-to-date as then current design and new technology will permit.

(The report in its classified form was signed by the Committee on November 15, 1982. The panel consisted of the following members:

Frank Baranowski
Wallace B. Behnke
Manson Benedict
Robert E. Hollingsworth
Thomas H. Pigford
William J. Howard, Vice Chairman
T. Keith Glennan, Chairman)

Senator THURMOND. Mr. Secretary, the 1982 Glennan report concluded that the experience with the high temperature gas reactor at Fort St. Vrain does not provide assurance that such a reactor can be built and operated reliably to meet production goals.

What has changed in the interim to influence the ERAB recommendation and your decision to proceed with this technology as a second source?

Mr. SALGADO. I believe lessons have been learned from Fort St. Vrain. This is a modular high-temperature gas reactor, different in design from light water or heavy water reactors. From all the scientific information available as well as the progress that they are making through the research site I believe the target development is well advanced. The NRC indicates that they are well down the reactor design path and the safety path and that there should be a reasonable assurance that this reactor can be built and operated safely.

But, as I indicated in my prior statements, there are technological milestones that have to be met before commitments are made by the Department to go further, and those issues, some of those such as the bearing and target development have been addressed by Mr. Cochran.

Senator THURMOND. Mr. Chairman, I think my time is up.

Senator EXON. Thank you very much, Senator Thurmond.

Mr. Secretary, let me go back to my concern on this cost proposition. But before I do that, I want to compliment you and the Department for your recent efforts to recognize some of the shortcomings that we have had in the past with safety. There is an awful lot more to be done in that area, but I want to compliment you for what you are trying to do in that area. And, of course, that is going to be a major concern in the future with regard to the amount of funding we get for these projects.

If there is any hint that we have even more serious problems than we have right now with the present facilities, that will, in my view, undermine public support for the new production reactors. It seems to me that one of the greatest problems that we face will be coming up with the billions that are needed to clean up and make safe what we have now. To date, we have done a very poor job in these areas. I think we can all agree on that.

And we will have to come up with the additional billions of dollars it is going to cost for these two necessary new reactors in the future. That is why I am concerned with the overlap years that we are going to have with your proposal. Let me press you a little bit more on that.

But if there would be a pinch on funds in the next few years, would it be safe to say that given the fact that we have had more experience with the heavy water reactor, that if there is a shortage of funds, it is most likely that the facility with the yet fully researched mechanisms that are planned for Idaho would likely to suffer because our first priority must be, it seems to me, to as quickly as possible get at least that Savannah plant on line.

So, is it fair to say that if there are budget constraints that the heavy water plant in Savannah would be favored by the Department generally without closing down the plans or construction of the Idaho plant? If we are short of money, it is more likely to come

from the Idaho plant than the Savannah River Plant, is that correct?

Mr. SALGADO. Mr. Chairman, that is correct. We have said all along we are willing to—we are committed to build a heavy water reactor at Savannah River to produce 100 percent of our tritium needs. And we have been firm across the board, and that was our first preference.

I think the important part, though, that I feel compelled to add, and your analysis is correct that if, in fact, it came and if, in fact, the Department were forced to make that one particular choice, that given the ERAB report and given the Glennan report and given our own technical confidence that we would have to move forward with the heavy water reactor.

But, at the same time, before that choice again, I would feel compelled to go to the President of the United States and the executive branch and say that these two reactors are a priority, and that we have to look, at the Department and as an executive branch, to reduce in other areas before we can allow ourselves to face the turn of the century with only one reactor supplying tritium. Because if that reactor goes down and we have not moved aggressively to bring another component on line, then the entire amounts that we have invested in our nuclear deterrent over the years and the billions and billions that we have invested will start to degrade and diminish.

Senator EXON. Thank you. I think that clears up for the record for what at least has been unanswered in my mind and should clear it up for the Congress.

In other words, if we can get the money to build both of them and have them both on line simultaneously, that would be the ideal goal.

Let me go into some of the differences in cost and otherwise. The Department of Energy has estimated, as I understand it, the cost of building two new production reactors, $6.8 billion in 1988 dollars.

I would like to ask several questions about these figures. First, what is the split on these figures between the heavy water reactor and the high-temperature gas reactor?

And, is it correct, then, that the gas reactor costs slightly more than the heavy reactor for half the capacity? For the water reactor in Savannah $3.2 billion and $3.6 billion for the gas reactor in Idaho are the figures I have. And if those figures are correct, is it not true that we would be getting from the standpoint of cost significantly more benefits from the heavy water reactor client?

Mr. SALGADO. Your bottom line is correct that on a pure dollar and cents capital cost basis that the $3.2 billion for the heavy water and $3.6 billion for the modular high-temperature gas reactor on a dollar and cents basis looking at—you are correct.

There is one other component there, that if the Department or the Government wanted to offset operating costs or diminish costs in out years, we can sell steam from the modular high-temperature gas reactor units to the utilities, and, therefore, have revenues coming in.

Obviously, as you are well aware, Mr. Chairman, with heavy water reactors there is no ability to generate steam and sell it. But

that is one other component which in all fairness needs to be asterisked with the $3.6 billion. But, your bottom line is correct.

Senator EXON. Is the cost of the two reactors included in the DOE's defense program budget?

Mr. SALGADO. The cost has been submitted in the DOE Defense Program's budget request to OMB at this time, that is correct.

Senator EXON. For both?

Mr. SALGADO. Yes, sir.

Senator EXON. Now, what programs will be cut to accommodate this funding or are you going to be asking for this in additional funding?

Mr. SALGADO. We have held the position and strongly believe that any NPR activity has to be above our 050 account merely because out year funding profiles would not allow continued operations meeting current demands as well as building of these new reactors. That will be—that is above our normal budget submission above the target line as we have referred to it. So, we will be looking for an increase in our 050 account.

Senator EXON. Well, then, it would be safe to assume that we would have to have an increase in the Department of Defense's portion of the budget, and here we go again with establishing our needs and making a good case to do it, but every one is wondering where we are going to get the money to pay for all of it. Thank you.

Senator Thurmond.

Senator THURMOND. Thank you very much, Mr. Secretary.

Mr. Secretary, safety, urgency and quality appear to capture the objectives underlying the Department's NPR acquisition strategy. Is this the case and how would you prioritize these objectives?

Mr. SALGADO. Obviously they all stand on equal footing. The urgency is obviously there. Safety has to have paramount importance merely because I do not believe that there is anyone in this room or in this country that would allow us to operate an unsafe reactor, and quality determines the amount of the effectiveness of our safety.

So all three of those aspects have equal footing and equal care because the reactor we build has to be safe, and we have to ensure that it has a long-term life so that it will be able to meet the country's needs well into the next century.

Senator THURMOND. Yes, I said quality. It should have been duality.

Let me ask that question over to be sure. Safety, urgency, and duality appear to capture the objectives underlying the Department's NPR acquisition strategy. Is this the case and how would you prioritize these objectives?

Mr. SALGADO. Well, obviously, the duality is the insurance that is going to be needed at the turn of the century. And to prioritize those I would go back to my response to the chairman that urgency and safety stand on equal footing; that we have to have a reactor up, we have to have the capability, and it has to be safe.

Duality is what is needed for the long-term assurance that this country has the capability to meet its needs. But safety and urgency to one reactor obviously has a major priority to us. We have to have that capability.

Senator THURMOND. Mr. Secretary, do you envision a situation where the object to provide for goal quantities of tritium on an urgent basis could be compromised by the objective of duality, specifically if budgets get tighter than you now envision, could this be the case?

Mr. SALGADO. Again, the only thing that it would force, it would force an executive branch and a congressional, legislative branch decision that to walk away from the duality aspect of it, again, I would have strongly stressed within the executive branch that the duality aspect of it is critical and needs to be addressed and cannot be postponed year after year because the length of time to bring these machines and these plants on line is too long a lead time.

So that obviously there is that possibility in the future with tighter budget constraints that there will be a determination made that duality may have to suffer so that we can benefit from safety and urgency.

Senator THURMOND. Mr. Secretary, if the Department is faced with budgetary pressures beyond those now envisioned, is it your view that the urgency of providing goal quantities of tritium should take priority over the desirability of duality and is the acquisition strategy structured such that these objectives are separable?

Mr. SALGADO. I believe it is structured, and I would agree that duality cannot control the ability to produce tritium; i.e., that we could not delay both projects for 5 additional years so we could maintain a duality track.

Our urgent need is to bring the heavy water reactor on line as soon as possible, meeting certain standards and that essentially that there are—within our process now there are exit ramps on the modular high-temperature gas reactor that we can basically either slow down or accelerate as needed, but we have indicated that there are exit ramps because of technological milestones that have to be met so that our proposal does allow for either a slowdown or more R&D activity in that arena.

Senator THURMOND. Mr. Secretary, is it clear that there is no civilian power application for low-temperature, low-pressure heavy water reactor envisioned for the NPR? Is it envisioned that development of the high-temperature gas reactor for duality purposes will make this technology more available for civilian applications and was this a consideration in this selection of this technology?

Mr. SALGADO. If I could bifurcate the question, first of all, I believe there may be a civilian use for the low-pressure, low-temperature heavy water reactor, but it is not economical in the United States. No one has ever considered that a low-pressure, low-temperature heavy water reactor could be utilized in the civilian sector.

I think the answer as to the modular high-temperature gas reactor that the first premise was, number one, to what technology were advanced and what duality important? There is a byproduct from that, and that byproduct is, the fact of the matter is that modular high-temperature gas reactors have some inherent and passive safety features that not only would we like to see in our production reactor, if we have one built, but also would be beneficial in the private sector.

And the answer is then, yes, the modular high-temperature gas reactor does have the possibility if this country turns back aggressively to the utilization of nuclear power, that that is a type of technology that could be utilized in the commercial arena.

Senator THURMOND. Mr. Secretary, I understand that high-temperature gas reactor development has been supported by research funding on the civilian side of the Department of Energy. Would such nondefense funding continue for this technology under the NPR acquisition strategy and do you see any adverse policy issues in the combining of civilian and weapons uses for a particular reactor technology?

Mr. SALGADO. The first answer to the question, Senator, is yes, there has been some modest funding in the past, and I do indicate that it has been modest. I think in the Department we have submitted something like $5–$10 million. It has been increased on the Hill through the appropriations and authorization process. So, we have had research and development going on on that side.

The one premise that I would like to dispel is that we are building this reactor, a modular high-temperature gas reactor, for commercial use. It is imperative that we do not commingle these two. Though the technology is the same, the target development is different for us, and, in fact, the design of our modular high-temperature gas reactor for our tritium production is different in the fact that we are utilizing containment vessels while the design for the modular high-temperature gas reactor on the civilian side does not.

I think that it is very, very difficult if, in fact, these two become commingled. We in the Department will continue research and development in the high-temperature gas reactor arena on the civilian side. We believe it is going to be needed in the future, and that will move forward. But we are making a very stringent effort to ensure that there is a demarcation, a line, if you will, that there is distance between these two because I think obviously this gets into a major public policy issue and debate on the utilization of civilian reactors for defense activities.

Senator THURMOND. Mr. Chairman, my time is up.

Senator EXON. Thank you, Senator Thurmond.

Mr. Secretary, with regard to the matter of cost, the average final cost of commercial nuclear reactors which have come on line since 1980 was eight times greater than the initial cost estimates. Were prior underestimates of the commercial reactor construction considered in putting together the figures that you have supplied us with?

What, if any, historical data from prior DOE construction was factored into the construction cost estimates for these new reactors? I would simply say that I would appreciate your providing for the record some of the details of this and possibly we could just use as a line of the costs on projects over $100 million that have taken place in the last 10 years. Do you have any general comments in this area? How sure are you of those figures?

Mr. SALGADO. I will ask Mr. Ron Cochran to address that. Obviously the figures are our best estimates in 1988 dollars and careful consideration has gone into those figures. Ron can give you a brief summary and then we will submit more detail for the record.

Mr. COCHRAN. I would just like to make the point that we did take into account the actual experience both on commercial construction and DOE construction in trying to come up with numbers that are realistic for the cost of these plants.

Clearly they are preliminary at this time because not much design has been done, and you need to get design before you can have precise cost estimates. But we did base both of those cost estimates on actual commercial experience on the quantities of materials, concrete, steel, this kind of thing, that go into these reactors. We took into account what had happened in the commercial nuclear industry, and the numbers that we have given you are our best guess at the realistic costs of these plants.

We need to refine those estimates as we get more information. They could come down; they could go up. But right now, we think they are realistic, sir.

[Additional information follows:]

Underestimates in previous commercial power plants were considered in developing the cost estimates for the NPR. However, a direct comparison between recently completed commercially funded power reactors and the government-funded proposed NPR cannot be made. Many commercial plants were delayed because of slippage in the growth of demand for new generating capacity brought on by the recession of the late '70's and because of regulatory backfits required after the Three Mile Island accident. The NPR design approach will be to achieve approximately 70 percent design completion before major construction begins. This along with a continuous safety certification process should enable the problems encountered by some of the commercial plants to be significantly mitigated.

In preparing their cost estimates, the NPR vendor/proponents included the latest versions of safety and environmental related equipment. The Cost Evaluation Technical Support Group (CETSG) also included compensation for possible underestimation in the contingency factor applied to each project. These factors were based on probabilistic cost/risk analysis and the results of a Rand Corporation cost growth study (The Megaprojects Study) which included several commercial reactors in its data base. In addition, the CETSG adjusted capital cost estimates compare favorably with estimates derived by an internal DOE Defense Programs independent cost estimate which utilized the Energy Economic Data Base maintained by United Engineers and Oak Ridge National Laboratory.

Regarding comparisons with the commercial nuclear industry, it must be noted that commercial reactor project costs include a very large proportion of interest costs (interest during construction) in their final costs. What was initially estimated to take 5–8 years to construct has instead taken 10 to 15 years, including periods of extremely high interest rates. The associated interest cost for these delays were large and in some cases were equal to or greater than the initial projected costs. The delays were mainly the result of intervention, backfitting of new equipment to meet post-Three Mile Island safety standards mandated by the NRC, and time-consuming resolution of quality assurance problems discovered after-the-fact. The initial commercial reactor cost estimates did not include the costs of retrofitting and in some cases rebuilding parts of the reactor to meet newer quality and safety standards. The NPR cost estimate assures that the construction task will be completed on schedule, that QA and safety matters will be handled and resolved prior to construction, and that the design scope of the project will remain the same over the lifetime of the project.

There is no recent cost data on DOE-constructed reactors available since no large reactors have been completed in the last few years. However, for the NPR support facilities, which are mainly chemical and metallurgical facilities, there is data based on recent upgrades to the weapons complex which were made to meet more stringent environmental standards. Such recent data was taken into account by the vendors and by the CETSG in estimating the support facility costs.

In summary, the estimates provided in the NPR capacity cost evaluation included the following assumptions: (1) The scope of the project remains the same (no major redesign); (2) the R&D, design, and construction schedules are met; (3) that an expeditious safety review process is achieved; (4) the NPR project meets current and reasonably projected environmental and safety standards; and (5) the estimates were

prepared using January 1988 constant dollars as well as using a real discount rate of 4%. No interest during construction is added.

DOE produces annually a report on the status of all construction projects with a cost of $100 million or greater, as requested in House Report 99-195 on the FY 1986 Energy and Water Appropriations bill. This report is provided to both the House and Senate Appropriations Committees. A copy of the latest report (May 3, 1988) is attached. An analysis of the report was performed to summarize the status and performance of the projects. The excerpted results are shown in the attached table.

Total Estimated Cost

| Title | % Complete | $M Original | $M Current | $M Variance |
|---|---|---|---|---|
| 77-13-f | 89.3 | 100.0 | 413.3 | 313.3 |
| 81-D-115 | 97.0 | 35.0 | 125.0 | 90.0 |
| 81-T-105 | 73.0 | 970.0 | 930.2 | - 39.8 |
| 81-T-112 | 93.0 | 103.0 | 137.0 | 34.0 |
| 82-D-107 | 75.0 | 626.0 | 898.6 | 272.6 |
| 82-D-124 | N/A | 126.0 | 364.7 | 238.7 |
| 84-D-... | 25.0 | 591.3 | 553.0 | - 38.3 |
| 84-D-112 | 86.0 | 96.0 | 154.6 | 58.6 |
| 84-D-135 | on hold | 155.0 | 255.0 | 100.0 |
| 85-D-139 | 86.0 | 270.0 | 284.0 | 14.0 |
| 86-D-130 | 6.0 | 120.0 | 120.0 | 0 |
| 86-D-148 | N/A | 504.0 | 550.0 | 46.0 |
| 86-D-149 | N/A | 210.5 | 410.4 | 199.9 |
| 87-D-159 | N/A | 60.0 | 302.2 | 242.2 |
| 87-R-203 | N/A | 236.0 | 265.0 | 29.0 |
| RA-1 | N/A | 173.1 | 257.3 | 84.2 |
| RA-2 | N/A | 118.7 | 176.0 | 57.3 |
| WS-1 | N/A | 81.0 | 273.5 | 192.5 |
| 88-D-105 | N/A | 210.0 | 210.0 | 0 |
| 88-D-122 | N/A | 154.1 | 235.8 | 81.7 |
| 88-D-123 | N/A | 109.7 | 109.7 | 0 |
| 88-D-173 | N/A | 680.0 | 920.0 | 240.0 |
| 89-D-172 | N/A | 180.0 | 180.0 | 0 |
| 88-R-902 | N/A | 357.0 | 426.0 | 69.0 |
| 89-R-450 | N/A | 4,010.0 | 4,010.0 | 0 |
| 89-R-601 | N/A | 456.0 | 456.0 | 0 |

# U S DEPARTMENT OF ENERGY

## STATUS OF PROJECTS
## WITH TOTAL ESTIMATED COSTS
## OF $ 100 MILLION OR MORE

April 1988

REPORT DATE

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ENRICHED URANIUM PRODUCTION FACILITIES 76-8-9

Status: Project terminated and being closed out.

| | Original | Current |
|---|---|---|
| TEC: | $4,500M | $2,780M |
| Schedule Completion: | 2nd Qtr. FY86 | 4th Qtr. FY90 (including lawsuits, audits and claims) |

Original Mission/Purpose:

The original project provided up to 8.75 million separative work units (SWU) per year of additional uranium enrichment capacity through the construction of new gaseous diffusion facilities adjacent to the existing cascade at Portsmouth, Ohio. The new facility will consist of several hundred stages (designated M-000 size) larger in both size and separative capacity than the existing uprated 000-size. The add-on gaseous diffusion plant will require enclosing about 200-300 acres of additional Government-owned land within the security fence plus acquiring a buffer zone adjacent to the add-on plant of about 300-400 acres, either by easement or by purchase.

Summary of Changes to the Mission/Purpose:

- Changed concept from gaseous diffusion to gas centrifuge. Increased capacity to 8.8M SWU using eight process buildings of gas centrifuges in 1977.

- Capacity increased to 13.2M SWU through use of advanced centrifuge machines in 1984.

- Project terminated due to change in market requirements and in favor of a competing technology in June 1985.

Reasons for Cost/Schedule Variances:

Costs on data sheets reflected in nonescalated dollars. Current estimate only includes costs through FY 1990, the end of the project termination. Delays were due to budget constraints and reexamination of current enrichment market requirements and competing technology advancements. Project termination costs are included in the current estimate.

WASTE ISOLATION PILOT PLANT 77-13-f

Status: Construction is 89.3* percent complete.

| | Original | Current |
|---|---|---|
| TEC: | $100.0M | $413.3M** |
| Schedule Completion: | 3rd Qtr. FY83 | 4th Qtr. FY88 |

*Considers additional FY88 construction.
**Pending review and approval of revised project plan.

Original Mission/Purpose:

This project provides for acquisition of land and oil, gas and mineral rights to the land for a 33 square mile radioactive waste terminal storage site (a 3 square mile principal site surrounded by a 2 mile buffer zone) and for the design of road, railroad, and utilities from existing sources to the site and site preparation. The actual storage horizon will be located between 2,000 feet and 3,000 feet below land surface in the lower segment of the Salado salt formation. Capability will be provided for the demonstration of low-level and intermediate-level transuranic contaminated waste storage methodology and operations and experiments with commercial high level waste.

Summary of Changes in Mission/Purpose:

- Original TEC was based on an upgrade of a mine in Lyons, Kansas. This concept was found to be unacceptable.

- Commercial spent fuel handling deleted from scope in 1982.

- Exploratory program to validate site suitability and confirm preliminary geotechnical design parameters was completed in March 1983.

- Operational reviews by DOE and operating contractor determined need for additional construction for safe operable facility. Construction will be completed at end of FY88. Additional construction does not delay planned receipt of first waste in October 1988.

Reasons for Cost/Schedule Variances:

Title II (Detailed Design) delayed from starting in July 1978 to February 1981. Construction start was delayed 2 years and completion delayed 3 years which caused most of the cost increase. The $100.0M TEC was a preliminary estimate. The first estimate based on completion of Title I design was $440.5M.

- Approximately $57M in cost savings/avoidances were identified. Some of these funds were returned to the project for a fourth shaft, modifications to underground mining, and an environment and safety building.

MISSILE-X WARHEAD PRODUCTION FACILITIES 81-D-115

Status: Construction is 97 percent complete.

| | Original | Current |
|---|---|---|
| TEC: | $35.0M | $125.0M |
| Schedule Completion: | 1st Qtr. FY85 | 2nd Qtr. FY89 |

Original Mission/Purpose:

The purpose of this project is to provide increased capability and capacity in the existing weapons production plants needed to produce the M-X warhead.

Facilities requiring building modifications and/or equipment to achieve the necessary M-X warhead production capability will include the Y-12 Plant, Oak Ridge, Tennessee; the Bendix Plant, Kansas City, Missouri; the Pantex Plant, Amarillo, Texas; the Pinellas Plant, St. Petersburg, Florida; the Rocky Flats Plant, Golden, Colorado; the Mound Facility, Miamisburg, Ohio; and the Savannah River Plant, Aiken, South Carolina.

Summary of Changes in Mission/Purpose:

- Change in Department of Defense weapon system design requirements, basing mode, etc., impacted original scope.

Current Mission/Purpose:

The project provides for construction of new production facilities required to produce a warhead for the reentry vehicle as adapted to the M-X System and a new warhead of enhanced safety design. The project estimate provides for the new production capabilities required to manufacture the warhead and provide for additional production.

Reasons for Cost/Schedule Variances:

Initial estimate was based on a tentative warhead design for a specific delivery system. The delivery system was changed in FY 1983 with a subsequent change in warhead design. This resulted in a substantial increase in warhead production requirements. The current TEC of $125.0M was established in March 1982 and has not been changed since then. Final funding was received in the FY 1985 Budget. Minor problems with completion of a subproject at the Kansas City Plant and settlement of claims has extended the completion schedule. However, all weapons production facilities have been completed and the Weapon Production Mission Requirements are being met on schedule.

DEFENSE WASTE PROCESSING FACILITY, SAVANNAH RIVER 81-T-105

STATUS: Construction is 73.0 percent complete.

| | Original | Current |
|---|---|---|
| TEC: | $970.0M | $930.2M |
| Schedule Completion: | 2nd Qtr. FY90 | 3rd Qtr. FY90 |

Original Mission/Purpose:

Liquid waste from irradiated fuel processing at the Savannah River Plant is presently stored in large underground tanks which have a limited life and require continuous surveillance. Conversion of high-level liquid wastes to suitable physical and chemical forms and subsequent confinement that both isolates the waste from human environment and provides minimal maintenance and surveillance requirements is a principal DOE goal.

This project will provide for construction of high-level radioactive liquid waste solidification and storage facilities at the Savannah River Plant.

A new processing area (200-S Area), near the existing H Chemical Separations Area, will be established. The new area will contain the waste solidification process building, waste storage building and new power, service and general facilities.

Summary of Changes in Mission/Purpose:

Facilities for immobilization of decontaminated salt in concrete (saltstone) have been included in the project eliminating the need for a follow-on project. In addition, glass waste storage capacity has been increased from 2 years to 5 years production.

Reasons for Cost/Schedule Variances:

The original TEC of $970M was reduced to $870M in 1985 due to process/facility operations optimization efforts and favorable economic conditions. Costs were increased from $870M to $945M because of engineering costs based on the results of testing, increased field material costs because of greater complexity and material requirements greater than anticipated. Decrease to $930.2M from $945M is due to transfer of scope to another project for the construction of an incinerator facility at the Savannah River Plant. Schedule slippage is due to constrained operating budgets.

MODIFICATIONS AND ADDITIONS TO PROTOTYPE FACILITIES 81-T-112

Status: Construction is 93 percent complete. The remaining work under this project is for DIG system installation.

| | Original | Current |
|---|---|---|
| TEC: | $103.0M | $137.0M |
| Schedule Completion: | 3rd Qtr. FY85 | 4th Qtr. FY89 |

Original Mission/Purpose:

This project provides for modifying the engineered safety features of several naval prototype nuclear propulsion plants, principally the S3G, S1C, and G1G land-based prototypes at West Milton, NY (S1C at Windsor, CT). The work primarily involves outriding the emergency fluid and electrical supply system capabilities and includes construction of necessary support buildings. This will provide system capabilities similar to those installed in the newest prototypes.

Summary of Changes in Mission/Purpose:

Deferral of the S3C plant overhaul due to budget constraints required modification of the plant's emergency system arrangement. This modification had no affect on the schedule for completion of this project.

Reasons for Cost/Schedule Variances:

The modification noted above does not affect the schedule for completion of this project, and may result in a minor cost savings pending negotiation of contract changes.

The cost schedule variances from the original data sheet are due to two factors:

- Approximately $7 million of the increase was caused by lower than anticipated funding profile in the early years of this project caused by budget constraints. This resulted in delays to construction contract placements, deferred the completion date, and required provision for inflation which resulted in revising the total estimated cost of the project to $110 million.

- The complexity of incorporating the new design safety systems into the existing prototype plants required additional controls and system features. This increased the estimated cost of the project by $27 million to a total of $137 million. The estimated completion date reflects construction contractor delays.

UTILITIES AND EQUIPMENT RESTORATION REPLACEMENT AND UPGRADE, PHASE III — 82-D-107

Status: Construction is 75 percent complete.

| | Original | Current |
|---|---|---|
| TEC: | $626.0M (FY82 $) | $898.6M (FY 1989 $) |
| Schedule Completion: | 4th Qtr. FY88 | 3rd Qtr. FY90 |

Original Mission/Purpose:

This project is a continuation of a multiyear program for restoration of utilities and capital equipment at the seven weapon production plants, the three weapons laboratories, and the Nevada Test Site. The project will provide for replacement of utilities and equipment that have deteriorated to the point that their physical condition is poor or is no longer technologically satisfactory. Restoration efforts will be accomplished at the Y-12 Plant, Rocky Flats Plant, Bendix Plant, Mound Facility, Pantex Plant, Savannah River Plant, Pinellas Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratories, and the Nevada Test Site.

Summary of Changes in Mission/Purpose:

None

Reasons for Cost/Schedule Variances:

The original estimate was stated in FY 1982 dollars and the current estimate is in FY 1989 dollars. This project has had a history of funding reductions in recent years which has resulted in a longer period of time to complete the project and cost estimate increases. FY 1989 as the final year of funding.

RESTORATION OF PRODUCTION CAPABILITIES, PHASES II THRU V 82-D-124

Status: A total of 15 subprojects out of 22 have been completed together with 223 of the tasks grouped under the two composite subprojects. This represents $259M of finished work.

| | Original | Current |
|---|---|---|
| TEC: | $126.0M* | $364.7M |
| Schedule Completion: | 2nd Qtr. FY86* | 3rd Qtr. FY90 |

* Phases I and II only.

Original Mission/Purpose:

The Restoration Project directly supports DOE's assigned mission of providing nuclear materials for national defense needs. The facilities and equipment involved are the prime source of weapon-grade materials within the United States.

This project provides for upgrading facilities for the production of nuclear materials in support of the national defense programs. Physical deterioration that has accumulated as a result of the aging of DOE's production plants at Savannah River, South Carolina; Hanford, Washington; Oak Ridge, Tennessee; and Fernald, Ohio, will be corrected.

Summary of Changes in Mission/Purpose:

Phases have been added to the project but the basic mission/purpose has not changed.

One subproject-- Central Powerhouse Control, Savannah River-- has been deleted from the original scope of work.

Reasons for Cost/Schedule Variances:

The original cost and schedule were for Phases I and II only. There has been no change in the general scope of work since the addition of Phase V in the FY 1985 budget. The project end date has been delayed a total of 21 months as the result of funding stretchouts. The effect on the Total Cost added to each phase is as follows:

| | |
|---|---|
| Phase III | TEC increased to $182M |
| Phase IV | TEC increased to $315M |
| Phase V | TEC increased to $367.3M in FY 1988 |
| | TEC decreased to $364.7M in FY 1989 |

The reduction in the TEC included in the FY 1989 budget reflects total costs for subprojects that have been completed and updated the estimate for the work remaining to be completed.

NUCLEAR WEAPONS RESEARCH, DEVELOPMENT AND TESTING FACILITIES REVITALIZATION — *84-D-107 & *85-D-102 & *88-D-106

STATUS: Construction initiated in the 2nd Qtr. FY 1984 and is now approximately 25 percent complete.

| | Original | Current |
|---|---|---|
| TEC: | $591.3M* (*Includes all 3 line items) | $553.0M |
| Schedule Completion: | 4th Qtr. FY92 | 4th Qtr. FY93 |

Original Mission/Purpose:

These projects provide for the construction of new facilities and modifications, relocations, and additions to existing facilities at the Nevada Test Site, the North Las Vegas Complex, the Los Alamos National Laboratory, the Sandia National Laboratories, and the Lawrence Livermore National Laboratory. It also includes some new equipment for revitalization of the nuclear weapons testing complex.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variances:

The original project completion date for 84-D-107 was 4th Qtr. FY 1992. However, when 88-D-106 was added, the project completion date was changed to 4th Qtr. FY 1993. This addition also changed the overall project percent complete from 46 to 25 percent.

NOTE: The Total Estimated Costs for the individual projects are:

| | |
|---|---|
| 84-D-107 = | $ 79.2M |
| 85-D-102 = | 156.5 |
| 88-D-106 = | 317.3 |
| | $553.0M |

TRIDENT II WARHEAD PRODUCTION FACILITIES 84-D-112

Status: Construction is 86 percent complete.

| | Original | Current |
|---|---|---|
| TEC: | $96.0M | $154.6M |
| Schedule Complete: | 2nd Qtr. FY88 | 4th Qtr. FY88 |

Original Mission/Purpose:

This project provides additional production and capability required to support production of the TRIDENT II Warhead. New facilities to be provided by this project include: equipment; building additions; renovation of some existing structures to adapt them for use in TRIDENT II production activities; and special facilities needed for production, certification, and assembly of components and complete warheads. This weapon will be the first to go completely through computer aided design and computer aided manufacturing.

Summary of Changes in Mission/Purpose:

Increased equipment and space requirements plus additional rail transportation vehicles have been added.

Reasons for Cost/Schedule Variances:

The initial estimate of $96.0M was based on a limited conceptual design and preliminary warhead design information. The warhead design and production requirements were changed which impacted facility requirements and costs. TEC of $158.5M was developed in January 1985, and was revised to the current TEC of $156.1M after reassessment of requirements was done in response to FY 1987 legislative actions. The current TEC was reduced to $154.6M in response to FY 1988 appropriations and accommodated primarily by recent cost underruns at Rocky Flats and Oak Ridge (Y-12).

PROCESS FACILITY MODIFICATIONS 84-D-135

Status: Design and procurement activities suspended as a result of decision to place N-Reactor in cold standby. The Department is currently seeking an alternate processing approach in line with the reduced Fast Flux Test Facility fuel mission.

| | Original | Current |
|---|---|---|
| TEC: | $155.0M | $255.0M |
| Schedule | 1st Qtr. FY92 | TBD |

Original Mission/Purpose:

The purpose of this facility is to provide the capability for processing Fast Flux Test Facility (FFTF) fuel at a reduced cost and processing and recovering plutonium from DOE-owned fuels not currently amenable to processing in the United States due to their cladding material, physical size or other technical or economical considerations.

This project will provide for modifications to the existing DOE-owned fuel processing facilities at the Hanford sites near Richland, Washington, for improved head-end fuel dissolution capability. The Process Facility Modifications (PFM) project will augment existing chemical processing capabilities by providing for the cladding removal and dissolution of FFTF and other DOE-owned plutonium bearing spent fuels. Subsequently, this dissolved fuel product, will be processed in the existing chemical processing facilities to separate the plutonium and uranium and convert to oxide products.

Summary of Changes in Mission/Purpose:

In 1985, the capability to process N-Reactor fuel was added to the project. Subsequently, in 1987, N-Reactor fuel processing mission equipment was deleted. However, the dual mission facility size and supporting systems were retained.

Reasons for Cost/Schedule Variances:

Project design activities were delayed until 4th Qtr. FY 1984 due to the 1-year funding deferral reflected in the FY 1985 congressional budget submission. Subsequently, FY 1985 funding was added by the Congress. A cost estimate increase of $30 million is based on the recently completed advanced conceptual design and reflects; (1) a 9-month delay in the initiation of design activities; (2) inadequate FY 1985 and FY 1986 funding to support the previous cost/schedule baselines; and (3) additional required facility safety and maintenance features. The balance of the cost estimate increase ($50 million) to $235 million represented an increase in the scope of the project to incorporate facility features and equipment to accommodate processing of N-Reactor fuel in PFM. The last $20 million net increase is due to FY 1987 and FY 1988 funding reductions imposed by stringent budgets delaying construction completion approximately 2 1/2 years and includes a reduction for the deletion of the N-Reactor specific fuel processing equipment. The project completion date is uncertain at this point in time because of the ongoing evaluation of alternative approaches.

FUEL PROCESSING RESTORATION, IDAHO FUELS PROCESSING FACILITY 85-D-139

STATUS: Design is 86 percent complete.

| | Original | Current |
|---|---|---|
| TEC: | $270.0M | $284.0M |
| Schedule Completion: | 4th Qtr. FY92 | 2nd Qtr. FY93 |

Original Mission/Purpose:

The Fuel Processing Restoration (FPR) project will replace portions of the deteriorated main processing facility solvent extraction systems with new facilities and process systems that will meet current codes and standards, and the demands of projected fuel processing loads. The resulting facilities will be designed to provide a minimum recovery rate of Uranium-235 per day to meet requirements, be capable of concurrent or sequential uranium recovery operations, have adequate intercycle and product storage or surge capacity to support concurrent or sequential modes, minimize personnel radiation exposures, minimize the spread of radioactive and chemical contamination, improve criticality safety, increase process availability, and minimize the release of radioactive effluents to the environment. The project will provide remote maintenance/replacement capabilities in those portions of the solvent extraction process which, due to high radiation hazards, decontamination time, and historically high maintenance requirements, cannot otherwise achieve the required process availability. Finally, the project will enable termination of the present practice of utilizing an injection well for the disposal of liquid service waste. After the FPR project is completed, an alternate disposal system will receive a reduced volume of cleaner (i.e., less contaminated chemically and radiologically) effluent from the recycle and cleanup systems of the Idaho Fuels Processing Facility provided by the FPR project.

Summary of Changes in Mission/Purpose:

None

Reasons for Cost/Schedule Variances:

The $14 million increase in the TEC (from $270M to $284M) is due to stringent FY 1987 and FY 1988 budgets. The results have 1) delayed start of construction by approximately 2 years; 2) delayed construction completion by 9 months and 3) forced a replanning of the facility's construction activities.

TRITIUM LOADING FACILITY REPLACEMENT 86-D-130

Status: Construction is 8 percent complete and the project is currently within cost and approximately 6 months behind schedule.

| | Original | Current |
|---|---|---|
| TEC: | $120.0M | $120.0M |
| Schedule Completion: | 4th Qtr. FY89 | 3rd Qtr. FY90 |

Original Mission/Purpose:

The purpose of this project is to replace aging tritium reservoir loading facility with a safer, more secure building, "state-of-the-art" equipment, and new process technology needed to improve reliability in supporting the weapon production schedule in FY 1989 and beyond.

The new tritium reservoir loading facility will be a maximum resistance, reinforced concrete structure, located adjacent to the existing tritium area buildings. The new structure will be approximately 200 feet long, 175 feet wide, and 23 feet high. An attached standard construction structure will house noncritical support facilities such as change rooms, storage areas, and noncritical support equipment.

Summary of Changes in Mission/Purpose:

None

Reasons for Cost/Schedule Variances:

Construction start was delayed while a report on the design and cost was prepared and submitted to Congress causing a stretchout of completion schedule from the 4th Qtr. FY 1989 to the 3rd Qtr. FY 1990. Requested FY 1987 and FY 1988 appropriations funding have been reduced. Lack of sufficient contingency funding is jeopardizing Savannah River Operations Office capability to maintain the required schedule and costs.

SPECIAL ISOTOPE SEPARATION (SIS) 86-D-148

STATUS: The SIS plant project was initiated in the fourth quarter of FY 1986 following issuance of the Conceptual Design Report. In FY 1988, work will proceed on definitive plant design, the construction and activation of engineering demonstration facilities, and finalizing environmental documentation. Initial site preparations will begin upon issuance of the Record of Decision.

| | Original* | Current |
|---|---|---|
| TEC: | $ 504.0M | $550.0M |
| Schedule Completion: | 4th Qtr. FY94 | 1st Qtr. FY95 |

Original Mission/Purpose

This project provides for the design, procurement and construction of the integrated Special Isotope Separation (SIS) Production Plant required to meet Defense Programs needs for isotopic purification of plutonium (Pu). The plant will be deployed in new facilities at the Idaho National Engineering Laboratory (INEL) and will employ the Atomic Vapor Laser Isotope Separation (AVLIS) process being developed by the Lawrence Livermore National Laboratory (LLNL). The AVLIS process is composed of two primary elements: the Pu separators and Pu processing operations, and the lasers and laser support processes. Two separator lines and the necessary support processes will be deployed in a Category I Plutonium Process Facility. The laser systems will be located in a separate Laser Support Facility linked to the Plutonium Process Facility by an optical beam tube.

Summary of Changes in Mission/Purpose:

The primary mission of the SIS project has not changed.

Reasons for Cost/Schedule Variances:

Th original TEC ($504 million) was based on estimates developed by the Richland Operations Office in their proposal to construct the SIS facility. Upon the decision to locate the facility at the Idaho National Engineering Laboratory, a bottom's up reestimate disclosed that additional funding for development activities increased the TEC to $530 million (FY 1988 budget request) resulting in a schedule slip for construction completion to FY 1995. Upon further review and analysis, including the receipt of additional FY 1988 funding, incremental requirements bringing the TEC up to $550 million (FY 1989 budget request) were identified for increased engineering, design, and project management activities and special robotics equipment. Facility operation is expected to be in 1995.

*Consistent with the SIS Deployment Management Plan transmitted on November 20, 1986, to the Senate Committee on Armed Services.

PRODUCTIVITY RETENTION PROGRAM, PHASE I, II, III, and IV 86-D-149

STATUS: The overall schedule on project 86-D-149, has been further extended as a result of Congressional funding reductions. Most subprojects are now in Title I or II design on the early stages of the project. However, the "Foster Wheeler Boiler Retubing" subproject at Richland has been completed together with V-II valve portion of Richland's N-Reactor Coolant System Components subproject.

| | Original | Current |
|---|---|---|
| TEC: | $210.5M | $410.4M |
| Schedule Completion: | 4th Qtr FY90* | 1st Qtr. FY94 |

*Phase I only

Original Mission/Purpose:

This project provides for modernization and upgrading of existing nuclear materials production facilities at Savannah River, South Carolina; Fernald, Ohio; and Richland, Washington.

Increased demands have been placed on the plants and equipment used to produce nuclear materials for weapons fabrications in recent years as the Department of Energy (DOE) attempts to satisfy the Department of Defense force structures specified in the Presidentially-approved Nuclear Weapons Stockpile Memorandum. The purpose of the Productivity Rentention Program is to increase the operating availability (utility factor) or efficiency of critical components or systems in keeping with this demand. It will also bring selected elements of the complex into compliance with technical or safety requirements that have either recently come into effect or that have only become applicable at the higher production rates now required.

Summary of Changes in Mission/Purpose:

The additional phases that have been added were included in the original mission definition. One Phase II subproject (the Radioactive Drain System, RL) was deleted during 1986. Three unfunded subprojects were deleted from Phase I in 1985. Work has been stopped on the N-Reactor subprojects and N-Reactor feed material tasks at the Feed Materials Production Center as a result of the Department's decision to place N-Reactor in cold standby.

Reasons for Cost/Schedule Variances:

The original cost and schedule targets were for Phase I only. Changes in the current TEC and schedule result from the addition of Phases II, III, and IV cost savings on some subprojects, and the deletion of unfunded subprojects and IV funding limitations.

Phase I TEC was $210.5M
Phase II increased TEC to $282.1M
Phase III increased TEC to $356.0M
Phase IV increased TEC to $410.4M

ENVIRONMENTAL, HEALTH, AND SAFETY IMPROVEMENTS, FMPC 87-D-159

Status: All ten of the Phase I subprojects have started design and six have been completed. Design has been initiated on 7 of 28 subprojects in Phase II. This represents $5,200,000 of work. The ESAAB of 10/14/87 approved construction of phase I subprojects and design and construction of selected phase II subprojects.

| | Original (1) | Current |
|---|---|---|
| TEC | $60.0M | $302.2M |
| Schedule Completion: | 4th Qtr. FY92 | 4th Qtr. FY91 |

(1) FY 1987 Congressional Construction Projects Data Sheet

Original Mission/Project:

The EHSI project provides additional needed facility improvements that will reduce hazardous discharges from the FMPC and ensure that plant operations; comply with Federal and State environmental and safety regulations; and will not pose a threat to the environment, the community, or the work force. Specific technical objectives incorporate air quality; water quality; material handling/waste management; and health and safety improvements.

EHSI consists of 116 subprojects divided into six phases with a TEC of $302.2M.

Summary of Changes in Mission/Purpose:

Phases have been added to the project for FY budget purposes, but the complete project scope consisting of six phases was identified during development of the conceptual design. The basic mission/purpose has not changed.

Several subprojects are on hold and are potential candidates for cancellation due to N-reactor impact.

Reasons for Cost/Schedule Variance:

The originally submitted cost and schedule was for Phase I only. The subprojects were reconfigured and Phase II was added in the FY88 budget. Phase III was added in the FY89 budget. While individual subprojects have incurred changes to the scope, cost, and schedule, and TEC of the project has not changed from that developed for the conceptual design.

| | |
|---|---|
| TEC Phase I | $ 60.0M |
| TEC Phase II | 22.0M |
| TEC Phase III | 72.7M |
| | $154.7M |

CONTINUOUS ELECTRON BEAM ACCELERATOR FACILITY 87-R-203

STATUS: Architect engineering was initiated in the second quarter of FY 1985. Construction started in the second quarter of FY 1987.

| | Original | Current |
|---|---|---|
| TEC: | $236.0M | $265.0M |
| Schedule Completion: | 2nd Qtr. FY92 | 2nd Qtr. FY93 |

Original Mission/Purpose:

The Continuous Electron Beam Accelerator Facility (CEBAF) is a single purpose, basic nuclear research facility to be located in Newport News, Virginia, on a site which includes the land and buildings once occupied by the Space Radiation Effects Laboratory (SREL).

CEBAF will be the only facility in the world capable of producing electron beams which simultaneously meet the criteria of high energy, continuous beams, and high intensity necessary to advance the frontiers of electromagnetic nuclear physics. CEBAF's electron linac, with its capability of providing intense continuous beams at any energy in the range of 0.5 to 4.0 billion electron volt (GeV), is designed to study the largely unexplored transition between the nucleon-meson and the quark-gluon descriptions of nuclear matter. In particular, it will study the extent to which individual nucleons change their size, shape, and quark structure in nuclear medium, study how nucleons cluster in the nuclear medium and study the force which binds quarks into nucleons and nuclei at distances where this force is strong and the quark confinement mechanism is important.

The accelerator facility will include: a 4 GeV, high intensity, recirculated continuous beam electron linear accelerator; experimental areas and equipment to conduct basic nuclear research; and buildings to house the accelerator complex and its operations and maintenance activities. The facility will possess a complement of equipment for initial experiments and supporting facilities to exploit the capabilities of the accelerator.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variances:

The reasons for the cost changes are as follows:

| | |
|---|---|
| o Plus cost due to revised funding profile | $24M |
| o Plus improved estimates of accelerator components | $11M |
| o Plus permanent office structure to replace modular units | $ 3M |
| o Plus increase of cryogenic testing program | $ 5M |
| o Minus effect of revised inflation factors | $14M |

Schedule change is a result of levels of funding in FY 1987, FY 1988, and FY 1989, which are lower than the original budget profiles.

MONITORED RETRIEVABLE STORAGE FACILITY 87-W-101

Status: On December 22, 1987, the President signed into law, Public Law 100-203 which contained the Nuclear Waste Policy Amendments Act of 1987 (NWPAA). The Department's proposal to locate a Monitored Retrievable Storage (MRS) facility in the Oak Ridge/Hartsville, Tennessee area was annulled and revoked by the enactment of the NWPAA. Additionally, the Act established a Monitored Retrievable Storage Review Commission to prepare a report on the need for an MRS facility as a part of the nation's nuclear waste management system. The report, together with the recommendation of the MRS Commission, shall be transmitted to Congress by June 1, 1989. After the MRS Commission submits its report to Congress the Department is authorized to conduct a survey and evaluation of potentially suitable sites for a MRS facility. The Department may not select a site from among those surveyed until after the Secretary recommends to the President a site for development as a repository. Moreover, the construction and operations of an MRS facility is subject to licensing by the Nuclear Regulatory Commission (NRC), and may not begin until a license for construction of a repository is issued by the NRC. The current schedule for submitting a license application to NRC for the development of a repository is 1995.

| | Original | Current |
|---|---|---|
| TEC: | $1,104.2M | N/A |
| Schedule Completion: | 2nd Qtr. FY96 | N/A |

Original Mission/Purpose:

The MRS facility will be designed to include all facilities and equipment to receive, unload, disassemble and consolidate, canister and ship to a geologic repository or to temporarily store onsite for subsequent shipment to a geologic repository, commercial spent fuel from nuclear reactors. The facility will be designed to receive and handle 3,000 metric tons of uranium (MTU) per year as spent fuel. It will also be designed to store and ship the hardware resulting from consolidation of the spent fuel assemblies and other radioactive materials from operation of the facility. An out-building lag storage capacity for 1,000 MTU of spent fuel in canisters is provided. An outdoor storage capacity of up to 15,000 MTU of spent fuel will be provided. Total possession limit of spent fuel on the site at any one time is 15,000 MTU.

Summary of Changes in Mission/Purpose:

See status above.

Reasons for Cost/Schedule Variances:

Note: This project is being deleted from the Department's Semiannual Report to Congress for Projects Exceeding $100 Million Total Estimated Cost, until such time that the conditions described in the NWPAA have been obtained.

EXPLORATORY SHAFT (ES) AT HANFORD, WASHINGTON, FOR THE FIRST RADIOACTIVE WASTE REPOSITORY — ES-1

Status: On December 22, 1987, the President signed into law, Public Law 100-23 which contained the Nuclear Waste Policy Amendments Act of 1987 (NWPAA). The Act directed the Department to terminate within 90 days site specific activities (construction of an exploratory shaft facility to conduct scientific site suitability tests) except for reclamation.

| | Original | Current |
|---|---|---|
| TEC: | $165.2M | N/A |
| Schedule Completion: | 3rd Qtr. FY90 | N/A |

Original Mission/Purpose:

The ES Phase I (first shaft activities) will consist of the first shaft and the preliminary in-situ testing in basalt for resolution of programmatic issues that must precede detailed in-situ characterization of a reference repository location (RRL). Phase I will consist of a borehole approximately 110 inches (279 cm) in diameter, lined with a 6-foot (1.8 m) inside diameter (ID) steel liner, capable of transporting personnel and materials to the proposed depth of approximately 3,400 feet. A shaft station with about 40 feet of drift will be located at approximately 60 feet to provide access to the reference repository horizon. Sump pumps, electrical service, ventilation air, and compressed air will be provided at depth.

The ES Phase II (second shaft activities) will be an addendum to the existing ES Phase I site and will consist of the second shaft, approximately 110 inches (279 cm) in diameter lined with a 6-foot (1.8 m) ID steel liner, and expanded surface and underground workings design to conduct in-situ testing in basalt for detailed characterization of a RRL. The shaft station will be expanded to about 1,100 feet of drift during Phase II containing service areas and test chambers.

Summary of Changes in Mission/Purpose:

See status above.

Reasons for Cost/Schedule Variances:

Note: This project is being deleted from the Department's Semiannual Report to Congress for Projects Exceeding $100 Million Total Estimated Costs.

EXPLORATORY SHAFT IN SALT FOR THE FIRST RADIOACTIVE WASTE REPOSITORY ES-2

Status: On December 22, 1987, the President signed into law, Public Law 100-203 which contained the Nuclear Waste Policy Amendments Act of 1987 (NWPAA). The Act directed the Department to terminate within 90 days site specific activities (construction of an exploratory shaft facility to conduct scientific site suitability tests) for reclamation.

| | Original | Current |
|---|---|---|
| TEC: | $210.3M | N/A |
| Schedule Completion: | 4th Qtr FY90 | N/A |

Original Mission/Purpose:

The objective of the exploratory shaft facility is to provide access to a selected salt horizon for detailed in-situ site characterization to acquire data necessary to support a license application to the Nuclear Regulatory Commission for construction and operation of a nuclear waste repository.

The project provides for construction of an exploratory shaft facility (ESF) in salt using two 12-foot finished inside diameter conventionally mined shafts. The site for the ESF will be selected from among seven currently considered. These sites are in the Davis and Lavender Canyon areas of the Paradox Basin in Utah, the Deaf Smith and Swisher County areas of Permian Basin in Texas, and three salt dome areas in Mississippi and Louisiana.

Summary of Changes in Mission/Purpose:

See status above.

Reasons for Cost/Schedule Variances:

Note: This project is being deleted from the Department's Semiannual Report to Congress for Projects Exceeding $100 Million Total Estimated Costs.

GRAND JUNCTION URANIUM MILL TAILINGS PROJECT RA-1

Status: An environmental impact statement has been drafted. Remedial action work has been initiated on over 300 vicinity properties.

| | Original | Current |
|---|---|---|
| TEC: | $173.1M | $257.3M |
| Schedule Completion: | 1st Qtr. FY88 | 4th Qtr. FY92 |

Original Mission/Purpose:

The purpose of the remedial actions is to stabilize and control the uranium mill tailings and other residual radioactive materials in a safe and environmentally sound manner in order to minimize radiation health hazards to the public.

The site is located on an alluvial flood plain and is surrounded by industrial developments. The total designated site covers about 105 acres. The tailings cover about 60 acres, the mill site and ore storage covers about 25 acres, and the remaining 40-acre area is the State-owned depository for the Grand Junction Remedial Action project. There are approximately 1.9 million tons of tailings on the site which have been stabilized with a 6-inch dirt cover. Most of the original mill buildings and other structures have been removed. During the period 1951-1970, approximately 2.2 million tons of uranium ore were processed at the mill site.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variances:

Cost estimate increased as a result of anticipated increased design and remedial action costs for processing site and vicinity properties. The Record of Decision for the Environmental Impact Statement (EIS) has not been approved because the pending Environmental Protection Agency groundwater standards impact must be added to the EIS. This should be accomplished in April 1988.

WEST VALLEY DEMONSTRATION PROJECT RA-2

Status: Major construction activities include progress on the Supernatant Treatment System and on the Liquid Waste Treatment System (LWTS) package.

| | Original | Current |
|---|---|---|
| TEC: | $118.7M | $176.0M |
| Schedule Completion: | 2nd Qtr. FY90 | 2nd Qtr. FY94 |

Original Mission/Purpose:

Public Law 98-368, West Valley Demonstration Project Act, authorized the Department of Energy, to carry out a high-level liquid nuclear waste demonstration project at the Western New York Nuclear Service Center near West Valley, New York, for the purpose of demonstrating the solidification and preparation of high-level radioactive waste for disposal. By virtue of demonstrating the solid vitrification of liquid high-level wastes, the potential hazards associated with continued storage of the liquid waste at the center will be diminished.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variances:

The original TEC of $118.7M was a preliminary TEC which was based on the preconceptual design information. In April of 1987, a TEC validation was conducted which supported an approved TEC of $116.3M based on more detailed conceptual design information. The current forecast of $126.0M is based on the following:

1. A revised estimate for the shielded solidification System which supports a $55M increase to the system TEC from the currently approved level of $35.4M to $90.4M.

2. A revised estimate for the Size Reduction Facility which supports a $1.6M increase to the system TEC from the currently approved level of $9.0M to $10.6M to reflect the adoption of a modular design for the Remote Size Reduction Facility to accommodate the uncertainty of shipment of spent fuel rods currently stored in the pool. (Contract Size Reduction Facility = $2.9M, Remote Size Reduction Facility = $7.7M.)

3. Overruns experienced on completed systems due to the incomplete design at the time of placement of construction contracts; and subcontractor performance problems;

| Systems | Approved 4/87 | Actual 12/87 | Delta |
|---|---|---|---|
| .STS | $19.4M | $20.0M | $ .6M |
| .LWTS | $12.4M | $14.3M | 1.9M |
| .CSS | $ 5.1M | $ 5.5M | .4M |

4. Escalation on rescheduled systems:

| Systems | Original | Revised | Delta |
|---|---|---|---|
| .SMS | $12.1M | $12.3M | $ .2M |
| .RSR | 7.7M | $ 8.1M | .4M |
| .HLWISF | 3.1M | $ 3.2M | .1M |
| | | | $ .7M |

SMS - Sludge Mobilization System

RSR - Remote Size Reduction

HLWISF - High Level Waste Interim Storage Facility

WELDON SPRING SITE REMEDIAL ACTION PROJECT WS-1

Status: The draft environmental impact statement was issued in February 1987. It was received by EPA as called for in the DOE/EPA Weldon Spring Federal Facilities Agreement. Radiological, chemical, and geological characterization of the site are continuing and will be completed in 1988. Conceptual design engineering has begun and will be completed this fiscal year. Surveillance, maintenance and monitoring are continuing activities.

| | Original | Current |
|---|---|---|
| TEC: | $81.0M (DOE Share) | $273.5M (DOE Share) |
| | | 114.3M |
| TOTAL | $81.0M | $387.8M |
| Schedule Completion: | 4th Qtr. FY96 | 4th Qtr. FY98 |

Original Mission/Purpose:

The Weldon Spring Site is located in St. Charles County, Missouri, about 30 miles west of St. Louis, on land formerly used by the Department of the Army (DA) as a trinitrotoluene (TNT) ordnance works. The site consists of a 3.4 ha (9-acre) abandoned limestone quarry; a 21 ha (51-acre) raffinate disposal area; and a 69.6 ha (169-acre) mothballed uranium feed materials plant. The feed plant was built during 1955-1957 by the Atomic Energy Commission (AEC), predecessor agency to DOE, and operated by Mallinchrodt, Inc., for the AEC from 1957 to 1966. During operations of the plant, the buildings, equipment, immediate terrain, process sewer system, and drainage easement to the Missouri River became contaminated with uranium, thorium, and their decay products.

On November 27, 1984, the OMB directed DOE to assume custody and accountability for the Weldon Spring Chemical Plant (WSCP) from the DA. The DOE was directed to assume responsibility for the decontamination of the WSCP and to integrate the work with other DOE remedial actions proposed for the Weldon Spring Quarry, Weldon Spring Raffinate Pits and Weldon Spring vicinity properties. The DOE and DA were directed to share the cost for the WSCP remedial actions. A Memorandum of Understanding regarding the site transfer and the allocation of funding sharing was approved on February 11, 1985. Transfer of custody and control of the WSCP was effected on October 1, 1985.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variance:

An original TEC of $81.7M was reported on the original data sheet submitted to Congress in the 1986 budget. Since that time the chemical plant was included in the project and funding became a joint responsibility between the Departments of Energy and Army. The addition of the chemical plant increased the cost to $222.7M (previously reported as the Original TEC). That estimate did not include $2.2M of maintenance and surveillance cost, nor did it include the Army's share which was estimated to be $127.8M for a total of $357.7M. Subsequently, the TEC was increased in the FY 1989 Congressional Budget Submission to $387.8M. This is the result of the completion of the conceptual design and a stretchout of the CERCLA schedule with EPA from 1966 to the 3rd Qtr. of FY 1987. However, the estimate is based on a preconceptual design report and is expected to change with the completion of the conceptual design.

The schedule increase is a result of the inclusion of the chemical plant.

SPECIAL NUCLEAR MATERIALS R&D LABORATORY 88-D-105

Status: Funding has been requested for FY 1989 for Title I and partial Title II design and to initiate sitework related construction.

| | Original | Current |
|---|---|---|
| TEC: | $210M | $210M |
| Schedule Completion: | 2nd Qtr. FY94 | 2nd Qtr. FY94 |

Original Mission/Purpose:

This project provides for a 91,200 square-foot Special Nuclear Materials Research and Development (SNM R&D) Laboratory Building, a 64,800 square-foot support building, 16,000 square-foot utility building, and for the decontamination, conversion, and refurbishment of laboratory space in the Chemistry and Metallurgy Research (CMR) Building for non-SNM chemistry use.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variances:

None.

FACILITIES CAPABILITY ASSURANCE PROGRAM (FCAP) 88-D-122

Status: FY 1988 funding will be used for design, site preparation, long-lead procurement and to initiate construction. FY 1989 funding will continue construction for the identified subprojects and initiate design and long-lead procurement on the next set of prioritized subprojects.

| Cost: | Original* | Current |
|---|---|---|
| TEC: | $154.1M | $235.8M |
| Schedule Completion: | Ongoing | Ongoing |

* 14 subprojects were included in the original FY 1988 TEC and schedule.

Original Mission/Purpose:

The purpose of FCAP is to rectify problems in the aging weapons complex building utilities and other real property.

FCAP is designed to maintain current nuclear weapons production capabilities into the future with a continuing program of replacing obsolete and inadequate facilities and utilities as they are required to maintain programmatic continuity.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variances:

TEC change reflects addition of FY 1989 subprojects. Sufficient funds were appropriated to start 10 of the 14 proposed FY 1988 subprojects and to fund their mortgages within the FY 1989 target. Based on latest appraisals, the 4 deferred FY 1988 subprojects could not be ranked above 5 proposed subprojects for FY 1989 new starts.

These 4 subprojects are now part of our FCAP backlog which is in excess of $400 million. The backlog projects are reprioritized annually based on the lastest appraisals programmatic requirements and availability of funds.

SECURITY ENHANCEMENT, PANTEX PLANT 88-D-123

Status: The requested FY 1988 funding will be used to initiate engineering and construction on eight subprojects.

| Cost: | Original | Current |
|---|---|---|
| TEC: | $109.7M | $109.7M |
| Schedule Completion: | 3rd Qtr. FY94 | 3rd Qtr. FY94 |

Original Mission/Purpose:

This project, which contains 34 subprojects, reflects the security enhancement required to improve the security of the Pantex Plant relative to the current threat matrix, vulnerability assessments, and knowledge known to date.

The project is subdivided into immediate and intermediate enhancement or subprojects. The immediate subprojects (24) will enhance security by implementing and improving systems used in the observation, detection, and denial of unauthorized exterior vehicles and personnel. Ten intermediate subprojects will provide facilities needed to support a larger security force and an enhanced security posture at the plant.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variances:

None.

HANFORD WASTE VITRIFICATION PLANT (HWVP) 88-D-173

Status: FY 1988 funds will be used for the initiation of definitive design and associated management activities.

| Cost: | Original | Current |
|---|---|---|
| TEC: | $680M | $920M |
| Schedule Completion: | 4th Qtr. FY96 | 1st Qtr. FY98 |

Original Mission/Purpose:

The facility will house vitrification process equipment and support services for immobilizing Hanford defense liquid high-level waste. The HWVP facility will occupy an area approximately 30-35 acres on the Hanford site. The HWVP process system will be based upon a liquid fed ceramic melter.

The HWVP facility will be divided into two major construction elements: Category 1 structures and steel-framed structures. The Category 1, reinforced concrete structures, will include: (1) process cells and a canyon area in the vitrification building, (2) fan house building, (3) sand filter facility, and (4) canister storage/canister loadout and shipping area which is attached to the vitrification building. The storage area will have a capacity up to 5 years. Steel-framed structures, with insulated metal siding, will be provided for the following: (1) service area which is attached to the vitrification building, (2) frit storage building, and (3) HEPA filter housing and plenum on the roof of the vitrification building.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variances:

Current cost estimate is not changed from the FY 1989 Congressional Budget Submission and is based on the completion of a 3-year conceptual design effort. The original cost estimate was based on the completion of about 6 months of conceptual design. The increase in the estimated cost reflects recognition of the greater complexity than originally envisioned and the benefits of technology transfer from Defense Waste Processing Facility (DWPF) and lessons learned from the West Valley Demonstration Project and foreign programs. The stretchout of the construction schedule allows full advantage to be taken of experience gained on DWPF and for leveling of the total defense budget for high-level waste vitrification facilities.

HANFORD ENVIRONMENTAL COMPLIANCE 89-D-172

Status: Project first funding is in FY 1989

| | Original | Current |
|---|---|---|
| TEC: | $180.0M | $180.0M* |
| Schedule Completion | TBD | TBD |

*Pending approval of Project Plan

Original Mission/Purpose

This project provides funding for capital improvements currently deemed necessary to achieve compliance with applicable environmental requirements at the Hanford Site. It consists of a collection of subprojects required to comply with the RCRA and other environmental regulations.

Summary of Changes in Mission/Purpose

The Total Estimated Cost is preliminary and will be updated as specific needs are defined. Subprojects with a TEC of $37.6 million has been identified and are included in the FY 1989 Congressional Budget Request.

Reasons for Cost/Schedule Variances

None.

COMPACT IGNITION TOKAMAK (CIT) 88-R-902

Status: Conceptual design is complete.

| | Original | Current |
|---|---|---|
| TEC: | $357.0M | $426.0M |
| Schedule Completion: | 4th Qtr. FY93 | 4th Qtr. FY96 |

Original Mission/Purpose:

The CIT project will provide for reconfiguration of the Tokamak Fusion Test Reactor (TFTR) facilities into an ignition upgrade of the TFTR facility. This compact, high field, copper coil configuration will enable low-cost ignition experimentation that will provide critical, burning-plasma data for successful future operation of an integrated Engineering Test Reactor.

Summary of Changes in Mission/Purpose:

None.

Reasons for Cost/Schedule Variances:

Cost and schedule changes are due to lower levels of funding in FY 1989, FY 1990 and FY 1991 than previously planned in the original budget profiles.

SUPERCONDUCTING SUPER COLLIDER (SSC) 89-R-450

Status:

| | Original | Current |
|---|---|---|
| TEC | $4,010.0M | $4,010.0M |
| Schedule Completion | 2nd Qtr. FY96 | 2nd Qtr. FY96 |

Original Mission Purpose:

The purpose of the Superconducting Super Collider (SSC) is to ensure forefront experimental capability for continued progress in advancing the frontier of knowledge of matter and energy at the most fundamental level, with resulting impacts on the Nation's science and technology base. The scientific work of the laboratory will be focused on the study of reactions among the elementary constituents of matter at the highest energies.

The SSC consists of a superconducting storage ring system in which counter-rotating beams of protons are made to collide at certain interaction points, producing ultra-high energy reactions for physics studies. The project includes a series of injector accelerators which provide the input beam for acceleration and circulation in the collider rings. The injector systems consist of a source and linear accelerator, followed by three booster synchrotrons in cascade. In addition to providing protons for injection into the two main rings, the final booster synchrotron alternately produces external beams for testing the response of detector components before their use in the interaction regions.

In the collider, oppositely directed bunches of protons, each with an energy of up to 20 TeV (20 trillion electron volts), are caused to collide with each other, almost head-on, making available a total of 40 TeV of energy in each proton-proton collision.

Summary of Changes in Mission/Purpose:

None

Reasons for Cost/Schedule Variances:

None

6-7 GeV SYNCHROTRON RADIATION SOURCE 89-R-601

STATUS:

| | Original | Current |
|---|---|---|
| TEC | $456.0M | $456.0M |
| Schedule Completion | 2nd Qtr. FY96 | 2nd Qtr. FY96 |

Original Mission Purpose:

The 6-7 GeV Synchrotron Radiation Source will serve as a national resource for the conduct of research by industry, government, and university scientists. It will produce unprecedented brilliant x-ray beams to serve the research needs of virtually all scientific disciplines and many technological fields, e.g., physics, chemistry, materials and surface science, biology, and medicine.

The accelerator complex will consist of a 200 MeV electron accelerator, a positron production target, a positron linac, an injector synchrotron to accelerate positrons to 6-7 GeV, and a positron storage ring. The storage ring will be housed in an annular building and will provide space for more than 80 experimental beamlines and related equipment. Funding for an initial complement of beamlines is included in this construction project. The injector synchrotron will be housed in separate, but related structure. The complex will also include: offices; general and special purpose laboratories; clean room laboratories; and miscellaneous service operations areas. Provisions are included for site access roads, parking service utilities and miscellaneous site amenities.

Summary of Changes in Mission/Purpose:

None

Reasons for Cost/Schedule Variances:

None

Senator EXON. In that regard let me ask you a question about overall safety and the protection and the location of these facilities as best we can. It has already been decided we are not going to change it, but I am wondering, have you figured into your projections making—using new techniques and new construction to protect against earthquakes which could be a major problem?

One hundred years or so ago there was a major earthquake not far from the Savannah River Plant, and I think there was also a 7.3 Richter Scale reading quake in Idaho, the same general area as the plant out there. No part of the United States is totally free from earthquakes, of course, but has it been addressed, and I hope it is being addressed in these cost estimates. Since these plants are so important, we need to build into them as best we can protection from some type of a natural disaster like that. Has that been considered?

Mr. COCHRAN. Yes, sir, it has been considered in a very preliminary way because the entire design is very preliminary at this point. But we certainly are going to take that into account in developing the design for both these plants. The contingencies that are contained in the cost estimate should provide adequate funding to cover any design modifications required for seismic purposes in building a new plant.

Senator EXON. Gentlemen, the last question I have has to do with the independent safety board.

An independent safety board for DOE's defense nuclear facilities was established, as you know, as a part of the recently passed defense authorization bill. The legislation directs that the board review the design of new facilities and to recommend modifications necessary to ensure adequate protection of public health and safety.

In what manner and at what point in the process do you expect the safety board to conduct this review? What will be the relationship between the safety board on the one hand and the recently created advisory committee on nuclear safety facilities on the other?

Mr. SALGADO. Mr. Chairman, as soon as the board is appointed by the new President and confirmed by the Senate and the staff is on line, we anticipate to involve them at the earliest possible date because I think it is important that they are brought on board expeditiously and that we move down this path of the construction of these new reactors as quickly as possible because of the need for urgency. We would hope to interface with them immediately upon their assembling as a board and with proper staff.

We will continue to utilize our own independent safety board that advises the Secretary not only in helping us move forward in the design of the new reactors, but also establishing the safety policies that were recommended by the National Academy of Sciences as well as other activities on our other facilities such as our plutonium handling facilities at Rocky Flats and other activities that we have going as you are well aware throughout the entire complex.

We need to establish how that liaison is going to work and how we are going to interact as a department with the two advisory boards as well as our own internal unit. And until such time as that board is created and its chairman is named, I have—I can

only indicate to you the general commitment that we plan on involving and integrating them in this process as soon as possible, not waiting until the end and handing them a fait accompli because we need to have their sign-offs early in this process to establish not only the credibility but from a cost factor and a building time factor that basically we are moving down the right track.

And I see them as an independent oversight board reviewing what we have done and doing what our outside experts have told us to ensure that we are maximizing our safety and environmental concerns.

Senator EXON. Thank you, Mr. Secretary. I have no further questions.

Senator Thurmond.

Senator THURMOND. Thank you, Mr. Chairman.

Mr. Secretary, what assumption are you now making in your budget planning with respect to funding for the NPR acquisition strategy? Specifically, is the NPR funded in the out years within the budget planning guidelines provided to the Department by OMB or if it is not, how does the Department intend to accommodate the NPR funding?

Mr. SALGADO. One moment, Senator.

[Pause.]

Mr. SALGADO. Right now, the new production reactor is in the over target line with OMB, and we have not had our passback nor our dialogue with either OMB or the White House on this.

We have had assurances from other components of the Government that this funding of a new production reactor will be covered, but the dialogue has not taken place on the 1990 budget timeframe other than our submission, sir.

Senator THURMOND. Mr. Secretary, you indicated in your testimony that your acquisition schedule is to proceed on an urgent schedule with construction of a heavy water reactor at Savannah River and concurrent preparation leading to construction of a high-temperature gas reactor in Idaho.

When would you envision starting at your construction for each of these reactors?

Mr. SALGADO. First, I should clarify the record so that I am technically correct that our preferred sites are the Savannah River site and the Idaho site. There is a NEPA process that has to go forward and I anticipate that that process is approximately 2 to 3 years until such time as final determination can be made under the legal requirements of NEPA.

I am looking at the schedule here and then if everything goes according to our schedule, we are looking at actual construction commencing in the 1994 timeframe. That means that all the design, the environmental work will be done, the safety and all that activity will be done, and construction may begin in the 1994 timeframe.

Senator THURMOND. Mr. Secretary, you indicate that the new production reactors will achieve a level of safety comparable to the best of current commercial reactors. Does the Department intend to translate this general goal into specific standards and when and by what process will such specification take place?

Mr. SALGADO. The bottom line answer is yes, Senator. We will make that into concrete, and it will be done through interaction be-

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tween our advisory board, ES&H within the Department, the program, and the new board that has been created through legislative mandate. We will be able once we have these boards in place, we will be able to put into process not only the development of these standards, but also that independent oversight from the legislative advisory board to assure that they are meeting comparability.

Senator THURMOND. Mr. Secretary, you indicate in your testimony that the Department will proceed on an urgent basis with safety and environmental reviews of the NPR. Will you outline for the committee the steps you have taken and the nature and expected duration of those reviews.

Mr. SALGADO. I would ask Mr. Cochran to give you the details on that, Senator.

Mr. COCHRAN. Yes, Senator. The NEPA review, National Environmental Policy Act review, is already under way. We issued in mid-September a notice of intent to prepare an environmental impact statement, and there are 12 scoping hearings planned for mid-November through early December to get that process moving promptly. That process will take about 2 to 3 years to get to the record of decision.

The safety review process is also under way. We are preparing the necessary documentation which can be reviewed by people outside the project to better understand what we are doing and how we are proceeding in the safety arena.

We do need to get the body of information that you identified earlier established and the working relationship established with the outside oversight committees as soon as possible so that we can move forward more vigorously on the safety review.

Senator THURMOND. Mr. Secretary, some view the current operational problems at the Savannah River reactors as an argument for duality. While I would not disagree with the desirability of duality, I see the current problems as first and foremost calling for decisive action to restore and to ensure public confidence in the ability of the Department of Safety to safely operate the weapons complex and to manage large projects. How do you view the current problems relative to the new production reactor?

Mr. SALGADO. Senator, I divide the operational problems currently at Savannah River, particularly the P reactor, as relevant only in that they are symbolic of what the Department needs to do and what the contractors need to do to be responsive to safety and environment.

I believe that the path that Secretary Harrington has started for us in the creation of ES&H, the path that we have taken with people on site, and the oversight committees have been given us, I see that basically that the new production reactor not only will be technically and scientifically advanced, but I think the Department at that time will also be comparable to those practices in the commercial world.

Senator THURMOND. Mr. Secretary, as I indicated in my statement, I have some concerns about the availability of Department resources to manage both the restoration of current reactor operations and the conduct of the new production reactor strategy. What can you tell the committee today to reassure us in that regard and will you provide for the record the staffing, including

qualifications and charter of the office of the new production reactors and the staffing and charter of the office charged with operation of the existing weapons complex.

Mr. SALGADO. Senator, we would be happy to provide that for the record. I would indicate that we also reviewed the resources of the Department, projecting the out years. It was the determination after consultations not only within the Federal branch, but with the private sector and with people in the utility business, and with people at NASA that had built major projects, that it was essential that we create a vertical structure within the Department so that we could pay attention to, and manage effectively and efficiently, the new production reactor.

And that is the reason we have created this new office that will report directly to the operating official within the Department because we believe that it will ensure the quality and the attention needed to carry forth. And by bifurcating this out, we also believe that the operations side of the house will not be able to drain resources away and be able to go forward after the continued operation of our facilities.

And so, the underlying premise is that by the separation of these two, we are ensuring effective and efficient operations both in current operations as well as the building of the new reactors. And we will supply the details as to FTE's for the record.

[The information follows:]

Attached are the staffing plan, mission and function statements for the Office of Nuclear Materials, and the Office of New Production Reactors.

The Office of New Production Reactors (ONPR) was established effective October 1, 1988. It is responsible for managing and directing a program for the acquisition and construction of new production reactor capacity to meet national security requirements. The Office provides for the planning and development of a program strategy and overall program management which considers safety, quality, environmental and performance matters in the design and construction of new production reactor capacity. Attached is an organization chart with functional descriptions.

An initial staffing complement of approximately 28 carefully selected professional and clerical employees assigned from within the Department is in place. Efforts are continuing to staff the Office up to 80 employees by the end of FY 1989. The professional technical staff will include engineers and scientists with experience in the design, construction, safety, quality assurance and operation of reactors and other nuclear facilities. In addition, a staff of environmental engineers and scientists will address environmental issues and concerns.

A strong vertically integrated program organization, the Office of New Production Reactors (ONPR), has been established. This Program Office reports directly to the Deputy Secretary as the Department's Chief Operating Officer and will maintain a close working relationship with Defense Programs (DP) and Nuclear Energy (NE) on the technical and systems engineering aspects of the New Production Reactors Program. In addition, major program aspects will be undertaken by the Savannah River, Idaho and Richland Operations Offices in coordination with the ONPR.

The ONPR will interact with a number of public and private organizations including Congress, the Office of Management and Budget, the Department of Defense, other Federal agencies State and local governments, public interest groups and the press/media. Appropriate safety oversight and advisory organizations within and external to the Department will be consulted on significant program milestones and activities.

The management structure of the ONPR includes:

*1. Office of the Director*

Develops overall management and policy direction for the New Production Reactors Program.

Develops and implements a program strategy for new production reactors.

Provides for legal counsel on program policy development through assignment of dedicated counsel for the Office and consultation with General Counsel attorneys.

Coordinates with Defense Programs and cognizant Operations Offices.

Consults with other Executive departments and agencies on matters relating to the NPR Program.

*2. Office of Systems Engineering*

Defines requirements for and conducts necessary research, development and testing (RD&T) to support design, construction, safety analysis, and documentation attendant to reactor development.

Develops functional design requirements and criteria.

Initiates conceptual/definitive design activities.

Prepares design descriptions for major plant systems and components with requirements and criteria.

Initiates support facilities requirements, definitions, analyses and assessments.

Maintains technical liaison and coordination with DP and NE.

*3. Office of Safety and Quality*

Provides safety and quality certification data.

Implements safety and quality assurance criteria.

Develops quality assurance (QA) strategy and program.

Develops reliability, availability, maintainability and inspectability program.

Develops and implements a strategy for interacting with appropriate safety oversight and advisory organizations.

*4. Office of Environment*

Assures environmental protection and quality.

Develops NEPA compliance strategy.

Prepares NEPA documentation.

Develops strategy for interacting with appropriate environmental authorities and organizations.

*5. Office of Congressional and Intergovernmental Relations*

Develops and implements a plan for interacting with and informing interested members of Congress and Congressional staffs on the status of the New Production Reactor Program.

Prepares and/or coordinates Congressional testimony, questions and answers and other informational work products within the NPR program.

In consultation with the cognizant Operations Offices, works closely with State and local authorities, as appropriate, on safety, environmental, siting, construction and other institutional matters.

Conducts a public affairs program.

*6. Office of Business Management*

Develops program and project planning strategy and reporting documentation.

Formulates, justifies and executes the budget for the NPR Program.

Performs program control activities, including schedules, milestones and cost/schedule control systems criteria.

Develops and executes a program acquisition strategy.

Provides administrative support, including office space, Automated Office Support Systems, records management, telecommunications, information management and equipment.

Provides personnel support and develops manpower allocation and utilization plans.

Coordinates with OMB and DOD on programmatic status and issues affecting the Program.

## OFFICE OF NUCLEAR MATERIALS PRODUCTION

### Mission

The Office of Nuclear Materials Production (ONMP) develops and directs DOE's program for nuclear materials production required for national defense, DOE programs, other federal agencies and industry, and overall Defense Programs Headquarters' coordination and management of activities related to major nuclear materials projects.

### Functions

Develops and directs programs of nuclear materials production to provide materials for national defense requirements and for DOE RAD programs, other government agencies, and industry.

Develops and directs a program to produce reactor fuel and to operate production reactors and processing facilities.

Directs programs to ensure operations are conducted in a safe, environmentally-acceptable, and cost-effective manner.

Directs programs to develop new and improved technology for nuclear materials production.

Develops planning documentation to support operation and maximize output of the ONMP production complex to meet special nuclear materials demand in the most efficient and cost-effective manner.

## OFFICE OF NUCLEAR MATERIALS PRODUCTION

## MATERIALS PLANNING DIVISION

### Mission

The Materials Planning Division, Office of Nuclear Materials Production (ONMP), carries out the nuclear materials planning function to assure the production of sufficient quantities of material to meet national defense needs.

### Functions

- Provides direction and planning for the DOE program to produce the nuclear materials to be utilized in military and civilian programs of the DOE, DOD, NASA, and others.

- In conjunction with the ONMP's Operations Division, assures the successful and efficient operation of the Defense Programs Nuclear Materials Production Complex through management of the reactor feed and nuclear material flows throughout the complex, optimization of material inventories and facility utilization, and coordination of material transfers into and out of the complex.

- Provides for near-term and long-range planning for nuclear materials through conducting long-range planning studies of supply capabilities and production initiatives and developing, in conjunction with DOD and Military Applications, the annual Nuclear Weapons Stockpile Memorandum to be submitted to the President.

## OFFICE OF NUCLEAR MATERIALS PRODUCTION

### PROJECTS DIVISION

**Mission**

The Projects Division, Office of Nuclear Materials Production (NMP), manages and directs project activities for NMP projects and oversees the Special Isotope Separation (SIS) research and development.

**Functions**

- Manages activities related to major nuclear materials production projects such as Facilities Restoration Program.
- Provides Headquarters management and direction for construction project activities at the SR, RL, OR, LLNL, and LANL field sites, providing guidance necessary to achieve the policies, objectives, and milestones associated with development and implementation of such projects,
- Develops project budgets and schedules, reviews and assesses contracting requirements, and provides guidance for reports required for tracking project progress.
- Maintains focal point for NMP Major Systems Acquisition programs.
- Conducts studies, formulates plans, reviews proposals, and monitors research and development in support of the SIS project.

## OFFICE OF NUCLEAR MATERIALS PRODUCTION

### OPERATIONS DIVISION

**Mission**

The Operations Division, Office of Nuclear Materials Production (ONMP), oversees the operations of the production reactors and related facilities and the operations of the chemical processing facilities and the operations of the chemical processing facilities to assure the production of sufficient quantities of nuclear materials to meet national defense needs.

**Functions**

- Provides overall program integration and management of the production reactors and chemical processing facilities, the performance of production-related research and development, and initiatives required to assure the production of sufficient quantities of materials to meet national defense needs.

- Provides overall program management for the operation of production reactors, chemical processing facilities, and supporting facilities to assure that they are operated in a safe, secure, efficient, and environmentally-acceptable manner.

- Provides overall integration for tritium production, separation and loading.

- Provides overall management and recovery operations for scrap nuclear material as well as for Pu-238 and transplutonium materials.

## OFFICE OF NUCLEAR MATERIALS PRODUCTION

### OPERATIONS DIVISION
### REACTOR BRANCH

**Mission**

The Reactor Branch, Operations Division, oversees the operation of the production reactors, the New Production Reactor (NPR), and related facilities.

**Functions**

- Provides program management for the operation of the production reactors, fuel fabrication facilities, reactor feed plants, and other associated facilities to produce sufficient quantities of nuclear materials to meet national defense requirements.

- Provides necessary program guidance for required production and development and implementation of restoration improvements and new initiatives to assure the future availability of sufficient nuclear material production capability to meet long-term material requirements.

- Assures that the facilities are operated and that programs are conducted in a safe, secure, efficient, and environmentally-acceptable manner.

- Maintains technical cognizance of the NPR; issues program guidance to the operations offices, contractors, and others as applicable.

- Manages overall Reactor Production Assurance Program activities, including technical performance, cost and schedule status and control; and approves changes to established baselines, including conducting reviews of technical documents, program status and audits.

OFFICE OF NUCELAR MATERIALS PRODUCTION

OPERATIONS DIVISION
PROCESSING BRANCH

Mission

The Processing Branch, Operations Division, oversees the operation of the chemical processing and related facilities.

Functions

- Develops policy for receipt and processing of irradiated fuels.
- Manages:
  - o Processing of irradiated production reactor fuel and targets.
  - o Tritium production.
  - o DOE inventories of scrap nuclear materials and recovery operation.
  - o Recovery of Pu-238 and transplutonium materials from special reactor targets.
  - o Process development activities for materials processing.
  - o Safety and environmental programs for materials processing.
- Develops technology for new and improved chemical processing capabilities.

## OFFICE OF DEFENSE WASTE AND TRANSPORTATION MANAGEMENT

**Mission**

The Office of Defense Waste and Transportation Management develops and directs DOE's programs for assuring that nuclear wastes are safely handled, treated, stored or utilized, transported, and disposed of to protect the public health and safety.

**Functions**

a) Provides for safe utilization or interim storage of defense radioactive wastes.

b) Develops alternative technologies and processes to support final waste disposal.

c) Develops an R&D facility to demonstrate geologic disposal of defense waste.

d) Implement the provisions of RECRA and CERCLA for defense waste programs and facilities.

e) Technical support to Defense Programs organizations for implementing activities to provide planned hazardous waste treatment, storage, and disposal facilities and remedial actions.

f) Provides for safe and efficient transport of DOE materials.

g) Maintains and cleans up surplus facilities from defense activities.

h) Develops, and tests packages for radioactive and hazardous materials

i) Assures program compliance with National Environmental Policy Act.

## OFFICE OF DEFENSE WASTE AND TRANSPORTATION MANAGEMENT

## OPERATIONS AND PROJECTS DIVISION

### Mission

The Operations and Projects Division, Office of Defense Waste and Transportation Management, oversees the management of radioactive waste operations at multiple DOE sites, supports the landlord programs at two DOE sites, and is responsible for phasing into operation major new facilities such as DWPF and the WIPP.

### Functions

- Directs the national program to assure the safe and environmentally acceptable operation of DOE radioactive waste facilities and storage and disposal sites (except programs under the Nuclear Waste Policy Act of 1982).
- Provides liaison with appropriate DOE and other Federal offices to assure the acceptability of radioactive waste management practices, procedures, and plans.
- Provides overall Defense Programs Headquarters direction and management oversight of landlord activities at the Hanford site and the Idaho National Engineering Laboratory.
- Manages radioactive waste operations and landlord activities to assure no adverse impacts on nuclear material production activities and integration with the long-term defense waste technology program, and to minimize the potential for adverse environmental impact.
- Provides guidance and direction to field project offices on matters of policy, program integration, funding decisions, and schedules.
- Conducts periodic headquarters project status reviews.
- Provides briefings and project information to Defense Programs and DOE officials.
- Assures compliance with environmental and other legislation and regulations.

## OFFICE OF DEFENSE WASTE AND TRANSPORTATION MANAGEMENT

## WASTE R&D DIVISION

### Mission

The Waste R&D Division, Office of Defense Waste and Transportation Management, manages the national technology development program to support operational requirements for defense wastes.

### Functions

- Develops programs for long-term management and confinement of long-lived radioactive waste, defining projects to demonstrate technologies and systems, and planning for full-scale operational facilities.
- Evaluates potential applications for defense nuclear byproducts and develops and implements beneficial uses.
- Provides Headquarters' direction to high-level waste, transuranic waste, and low-level waste technology lead organizations in the DOE field structure.
- Supports a program for adaptation or development of technology to improve current generation, storage, and disposal practices for hazardous and mixed wastes, as well as for remedial actions for some previously disposed wastes.
- Provides liaison between Defense Programs and the Office of Civilian Radioactive Waste Management on matters of permanent disposal of nuclear waste.

## OFFICE OF DEFENSE WASTE AND TRANSPORTATION MANAGEMENT

## TRANSPORTATION MANAGEMENT DIVISION

### Mission

The Transportation Management Division, Office of Defense Waste and Transportation Management, directs the DOE transportation R&D, Transportation Operations and Traffic Management, and Packaging Operations Management Activities.

### Functions

- Develops and promulgates DOE policies and procedures for the administration of DOE radioactive materials and other hazardous materials packaging operations.

- Directs the DOE-wide transportation and traffic management support programs for the movement of all materials with emphasis on hazardous, radioactive, and explosive material (excluding weapons).

- Directs DOE nuclear waste and byproducts transportation research and development and assures availability of transportation systems.

- Provides transportation operations and traffic management support to all DOE programs pursuant to DOE's statutory and regulatory authorities cited in 41 CFR 109.40, DOE Orders 1540.1 (Materials Transportation and Traffic Management), and 1540.2 (Administrative Procedures for Hazardous Materials Packaging for Transport).

- Represents the Department in activities involving transportation operations and traffic management with the carrier industry, carrier associations, Federal and State regulatory authorities, and other Government agencies.

- Provides centralized expertise and management of DOE-wide transportation and packaging activities, including:

    - Regulatory compliance training
    - Emergency response training
    - Public information

## OFFICE OF DEFENSE WASTE AND TRANSPORTATION MANAGEMENT

## HAZARDOUS WASTE AND REMEDIAL ACTIONS DIVISION

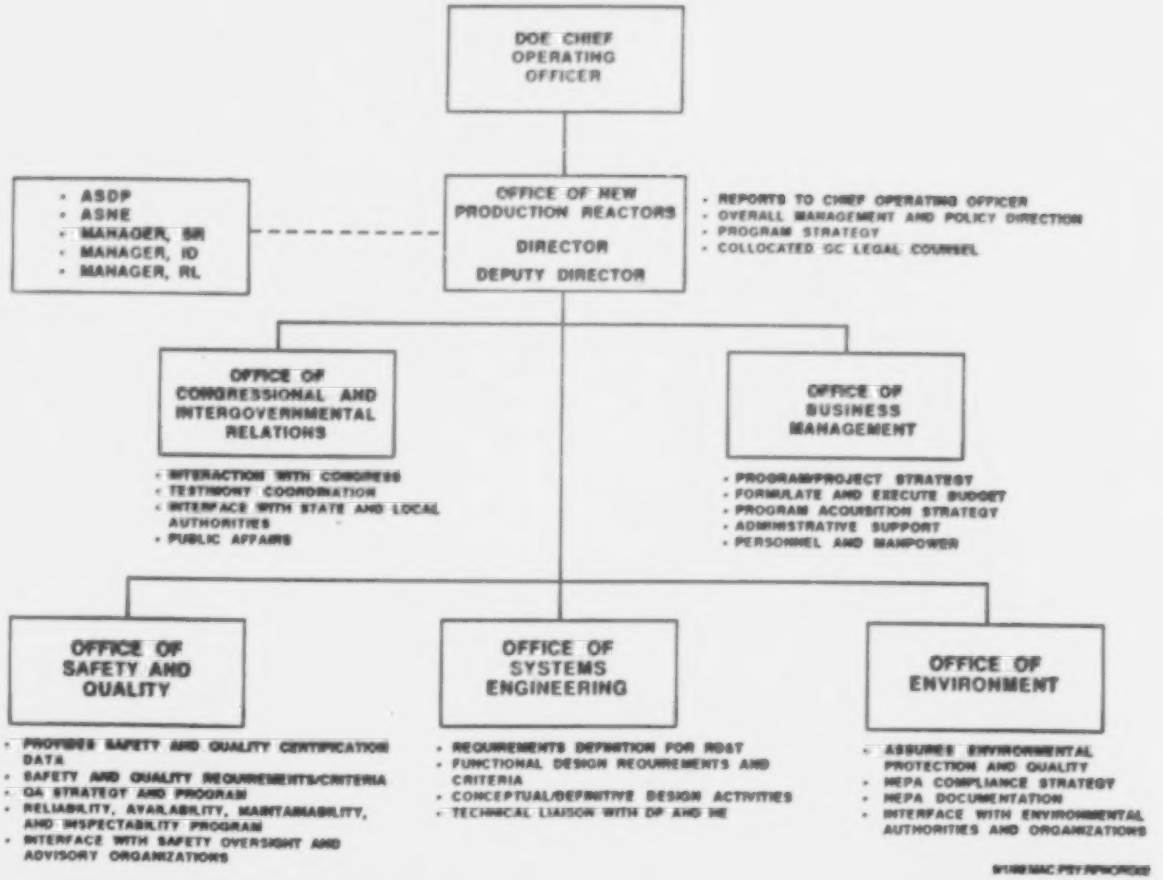
### Mission

The Hazardous Waste and Remedial Actions supports implementation of Defense Programs responses to legislation and regulations governing treatment, storage, and disposal of hazardous wastes and restoration of inactive sites containing hazardous materials, and manages the Defense Programs Decontamination and Decommissioning Program.

### Functions

- Develops and maintains Defense Programs plan for hazardous waste remedial actions.
- Provides technical support to DP program offices and field organizations in the identification and correction of deficiencies in handling, treatment, storage, and disposal of hazardous wastes.
- Analyzes DP remedial action funding requests and recommends (to ASDP) appropriate funding levels and priorities for hazardous waste projects.
- Maintains a data base covering hazardous and mixed waste generation and inventory; treatment, storage, and disposal facility information, and; technology that can be adapted to site specific requirements for facilities and remedial actions.
- Provides Headquarters direction to the Hazardous Waste Remedial Actions Program lead DOE field organization.
- Directs the Defense Decontamination and Decommissioning Program, including integration with the Assistant Secretary for Nuclear Energy Surplus Facilities Management program.
- Provides environmental activity support to all Defense Waste and Transportation Management programs.

# NEW PRODUCTION REACTORS PROGRAM


DOE CHIEF OPERATING OFFICER
OFFICE OF NEW PRODUCTION REACTORS
DIRECTOR
DEPUTY DIRECTOR
• REPORTS TO CHIEF OPERATING OFFICER
• OVERALL MANAGEMENT AND POLICY DIRECTION
• PROGRAM STRATEGY
• COLLOCATED GC LEGAL COUNSEL
• ASDP
• ASNE
• MANAGER, SR
• MANAGER, ID
• MANAGER, RL
OFFICE OF CONGRESSIONAL AND INTERGOVERNMENTAL RELATIONS
• INTERACTION WITH CONGRESS
• TESTIMONY COORDINATION
• INTERFACE WITH STATE AND LOCAL AUTHORITIES
• PUBLIC AFFAIRS
OFFICE OF BUSINESS MANAGEMENT
• PROGRAM/PROJECT STRATEGY
• FORMULATE AND EXECUTE BUDGET
• PROGRAM ACQUISITION STRATEGY
• ADMINISTRATIVE SUPPORT
• PERSONNEL AND MANPOWER
OFFICE OF SAFETY AND QUALITY
• PROVIDES SAFETY AND QUALITY CERTIFICATION DATA
• SAFETY AND QUALITY REQUIREMENTS/CRITERIA
• QA STRATEGY AND PROGRAM
• RELIABILITY, AVAILABILITY, MAINTAINABILITY, AND INSPECTABILITY PROGRAM
• INTERFACE WITH SAFETY OVERSIGHT AND ADVISORY ORGANIZATIONS
OFFICE OF SYSTEMS ENGINEERING
• REQUIREMENTS DEFINITION FOR RD&T
• FUNCTIONAL DESIGN REQUIREMENTS AND CRITERIA
• CONCEPTUAL/DEFINITIVE DESIGN ACTIVITIES
• TECHNICAL LIAISON WITH DP AND HE
OFFICE OF ENVIRONMENT
• ASSURES ENVIRONMENTAL PROTECTION AND QUALITY
• NEPA COMPLIANCE STRATEGY
• NEPA DOCUMENTATION
• INTERFACE WITH ENVIRONMENTAL AUTHORITIES AND ORGANIZATIONS

Senator THURMOND. Does either the research and development arm of defense programs or the material production arm have substantial experience with the high-temperature gas reactor technology for application to tritium production?

Mr. SALGADO. No, they do not. But in all fairness, I think I would have to add that as to the heavy water reactor, there is a lot of data that has been accumulated. Most of that data is in possession of our contractor, du Pont, obviously in that internally within the Department I do not think that we have a sound technical base in either one of those technologies other than through our management interface with du Pont.

Senator THURMOND. Mr. Secretary, to somewhat summarize your positions as I have conceived them this morning, and correct me if I misstate, you recommend both technologies, the high water and the gas technology. You recommend the first priority being the Savannah River Plant which will supply 100 percent of the tritium needed, but as a standby or as an addition thereto, the gas technology in the event of an emergency should come which would supply 50 percent of tritium needed. Is that correct?

Mr. SALGADO. That is correct.

If I can make one addition to that, Senator, and that would be this. That at the turn of the century that if this country needs plutonium and the supply that goes into the SIS production is nonexistent, we will also need a reactor for the production of plutonium, and that is one of the benefits we get from the utility or duality of those two reactors coming on line sometime near the turn of the century. That is correct.

Senator THURMOND. I want to thank you very much, Mr. Secretary, and thank you, Mr. Cochran and Mr. Wade and Mr. Baynard.

Senator EXON. Thank you, Senator Thurmond.

Gentlemen, thank you for being here. There will be some questions that we will submit to you for the record. We would like you to respond as promptly as you can. Thanks for being here. We appreciate it very much, and we are adjourned.

[Questions with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR J. JAMES EXON

HIGH TEMPERATURE GAS REACTOR (HTGR)

Senator EXON. The Department is proposing that the second new production reactor be a high temperature gas reactor.

Has the United States ever produced one of these reactors for tritium production?

Mr. SALGADO. No. An HTGR has not been used for tritium production in the United States, although this technology is capable of being used for that purpose. The United States' tritium production capability is presently based entirely on the heavy-water reactor technology in use at the Savannah River Plant.

Senator EXON. Has the technology needed for the fuel and target cycle in a production reactor ever been developed or used before in an HTGR?

Mr. SALGADO. Target technology is at an advanced stage of development for the HTGR. Further verification and qualification testing is expected to confirm that this technology is suitable for the proposed new tritium production reactor. The reference tritium targets are graphite and silicon carbide coated lithium aluminate particles that are similar in coating design to the fuel particles currently used at the Fort St. Vrain power plant. Statistically significant numbers of reference target particles have been irradiated for times shorter than required for production, but at levels of lithium burnup and temperatures that exceed expected NPR service conditions.

The fuel technology needed for a new production reactor has been used in HTGRs. The current fuel technology uses silicon carbide and pyrolitic carbon coating of individual fuel particles. This fuel technology has been used for the fuel for the Peach Bottom 1 and Fort St. Vrain reactors in the United States; a variation of this technology has been used for the fuel for two HTGRs in the Federal Republic of Germany: the Arbeitsgemeinschaft Versuchs Reactor (AVR) and the Thorium High Temperature Reactor (THTR-300). The specific fuel form for the proposed NPR/MHTGR will need to be validated for NPR utilization. If HWR fuel assembly design changes are implemented, these revisions would also have to be validated.

Senator EXON. Have any gas-cooled reactors been built in the United States?

Mr. SALGADO. There have been two major HTGRs built in the United States. Peach Bottom 1, a prototype HTGR having a thermal power of 115 MWt, was built in Pennsylvania in 1967 and operated for about 7 years. Fort St. Vrain, a commercial HTGR having a thermal power of 842 MWt, was built in Colorado in 1973 and is in operation. The utility industry ordered a number of HTGRs in the 1970s and they received favorable licensing reviews by the NRC.

There have also been two major HTGRs built in the Federal Republic of Germany that are of relevance to the new production reactor. The AVR (Arbeitsgemeinschaft Versuchs Reactor), a small experimental reactor having a thermal power of 46 MWt, was built in 1967 and is still in operation. The THTR-300 (Thorium High Temperature Reactor), a prototype HTGR having a thermal power of 730 MWt, was built in 1985 and is in operation.

Senator EXON. What is their operating record?

Mr. SALGADO. The operating record of the Peach Bottom 1 HTGR was excellent; over its 7-year life, the average availability was 87 percent. The operating record of the Fort St. Vrain HTGR is poor; over the past 8 years of commercial service, the average availability has been 27 percent. In 1987, however, a number of operational problems were overcome and the availability was improved.

The operating record of the German AVR is good; over the past 20 years it has averaged an availability of 68 percent, which is high considering the experimental usages of the reactor. An operating record for the THTR-300 has not yet been established. Over the past 2 years, the need for plant improvements and systems modifications have prevented long periods of reactor operation.

Senator EXON. What kind of delays would it be reasonable to expect in developing a new technology?

Mr. SALGADO. The HTGR technology is not new. The modular HTGR proposed for the new production reactor has been under development for several years. The most likely problem areas would be: tritium product yield, system reliability and integration, and safety evaluation. Improved design and technology issues will also be an integral part of the HWR concept.

*Tritium product yield.* Although the tritium targets appear to be technically sound, it is also necessary to have high confidence that target irradiation in the reactor will be effective and reliable. It is likewise necessary that target recovery processes be highly efficient so that the MHTGR production complex will meet the tritium production requirements. Target and reactor research and development programs and a performance/reliability testing program are being designed to address these concerns.

*System Reliability and Integration.* Any new HWR or HTGR reactor design, even if based on proven technology, could take longer than anticipated to eliminate performance and safety concerns. It will be necessary to make sure that the experiences with existing HWRs and HTGRs both in the United States and elsewhere, are correctly interpreted and applied, and that the various components and systems are effectively integrated in the new reactor to achieve the desired safety and reliability. To aid in assuring this integration, DOE intends to use the expertise available in the existing nuclear power industry and DOE National Laboratories.

*Safety Evaluation.* The NRC completed reviews for two applications to construct HTGRs and concluded that all safety issues could be satisfactorily resolved. The NRC is currently reviewing the safety and licensability aspects of a conceptual modular HTGR similar to that proposed for tritium production. Any new reactor design will have to receive extensive reviews to confirm that all safety issues have been resolved before construction can proceed. The safety research and development program, and a program for close coordination with independent safety reviewers and safety experts are being designed to address these concerns.

NPR AND THE SRP REACTORS

Senator EXON. Recently there has been much concern about the operational safety of the reactors located at the Savannah River Plant, where DOE plans to build the first NPR. What is the relationship between those concerns, particularly as identified by the National Academy of Sciences, and a new production reactor based on heavy water technology?

Mr. SALGADO. The National Academy of Sciences (NAS) recommended replacement of the aging Savannah River reactors. We estimate this replacement will take 10 years. The concerns identified by the NAS and others will be instrumental in guiding the conceptual evolution and design of the new heavy water production reactor at the Savannah River Plant.

The NAS appropriately indicated that there are uncertainties associated with the knowledge base and that additional technical data to support safety analyses is needed. The proposed HWR NPR concepts will be designed recognizing and fully addressing the potential safety concerns associated with the SRP reactors. We are confident that if sound engineering is applied along with the "lessons learned" from past HWR operations, a reactor concept can be created that is robust from a safety standpoint and reliable from a material production standpoint.

Senator EXON. Another related concern has been whether the contractor kept DOE fully informed of all serious reactor incidents. Westinghouse is to take over the Savannah River operations in April 1989. What changes will DOE make in its working relationships with its new contractor to ensure that DOE is kept more fully informed and that the public can have greater confidence in its operations?

Mr. SALGADO. The reporting criteria have been revised for all contractors to provide a lower threshold at which incidents and anomalous events are being reported to DOE. In addition, the new external safety board under Public Law 100–456 and the already established independent DOE Advisory Committee on Nuclear Facility Safety also will be part of the oversight process. This will provide DOE with independent and external expert advise. With respect to the new contractor at SR, the Department has structured a safety framework for startup and operation of the production reactors in a more rigorous and structured approach based on safety needs.

NPR SELECTION CRITERIA

Senator EXON. The Energy Research Advisory Board (ERAB) is an independent board which reviewed and assessed the technologies considered for the NPR. Among the six criteria used for evaluating candidate technologies, the Board stressed that the primary criteria are (1) the ability to produce goal quantities of tritium on a timely schedule, and (2) the ability to meet safety and environmental requirements. Why are these two criteria the most important?

Mr. SALGADO. There are potential national security risks associated with interruption of the Nation's tritium supply. Tritium is required for both new nuclear weapons and for replenishment of the stockpile. Approximately 5 percent of the total tritium inventory is lost each year through natural radioactive decay (12.3 year half-life). This high rate of radioactive decay makes preproduction costly and of only limited usefulness. Accordingly, tritium must be provided on a continuous and as-needed basis and the ability to produce tritium on a timely schedule is a primary criteria.

The safety and environmental requirements were created as equally important criteria to reflect the Department's commitment to designing, building, and operating reactors which protect against environmental degradation and protect the health and safety of the public and our workers. In addition, it should be noted that features incorporated to protect the health and safety of the public and workers assure the continued operation of this national security asset.

ADEQUACY OF TECHNOLOGIES TO MEET CRITERIA

Senator EXON. According to the ERAB, the reactor's target technology is the technical feature that discriminates between the reactor technologies that were considered for the NPR. According to the independent board, the heavy-water reactor "has a fully developed and proven target technology as a result of our long experience at the Savannah River Plant, while the other reactor types require further research, development, or qualification testing." The Board concluded that "uncertainties in the schedule and cost of the NPR that would arise from the use of a technology that requires further development and testing was a major concern of the Board, and outweighed other schedule and cost concerns such as those due to the safety

review process." Does the Department of Energy support these conclusions of the ERAB?

Mr. SALGADO. The Department believes that a carefully developed heavy-water reactor can proceed successfully through a rigorous safety review process, although no reactor of the type proposed has been subject to the current safety certification review process. Target technology for the other reactor concepts likely can be fully developed given sufficient time and funding. The HWR tritium production technology was rated most mature by the ERAB followed by the MHTGR with the next most advanced tritium target technology. DOE has implemented the current program strategy based in large measure on these findings.

### NPR PROGRAM MANAGEMENT

Senator EXON. The NPR will likely be DOE's largest construction program over the next decade. DOE's record in managing large construction programs is mixed. A number of programs have exceeded their estimated costs and have been subject to substantial schedule delays.

What is the Department's management plan for the NPR? Has a management structure already been established?

Mr. SALGADO. A strong vertically integrated program organization, the Office of New Production Reactors (ONPR), has been established. This program office reports directly to the Deputy Secretary as the Department's chief operating officer and will maintain a close working relationship with Defense Programs (DP) and Nuclear Energy (NE) on the technical and systems engineering aspects of the New Production Reactors Program. In addition, major program aspects will be undertaken by the Savannah River, Idaho and Richland Operations Offices in coordination with the ONPR.

The ONPR will interact with a number of public and private organizations including Congress, the Office of Management and Budget, the Department of Defense, other Federal agencies, State and local governments, public interest groups and the press/media. Appropriate safety oversight and advisory organizations within and external to the Department will be consulted on significant program milestones and activities.

The management structure of the ONPR includes:

*1. Office of the Director*

Develops overall management and policy direction for the New Production Reactors Program.

Develops and implements a program strategy for new production reactors.

Provides for legal counsel on program policy development through assignment of dedicated counsel for the office and consultation with general counsel attorneys.

Coordinates with Defense Programs and cognizant operations offices. Consults with other executive departments and agencies on matters relating to the NPR Program.

*2. Office of Systems Engineering:*

Defines requirements for and conducts necessary research, development and testing (RD&T) to support design, construction, safety analysis, and documentation attendant to reactor development.

Develops functional design requirements and criteria.

Initiates conceptual/definitive design activities.

Prepares design descriptions for major plant systems and components with requirements and criteria.

Initiates support facilities requirements, definitions, analyses and assessments.

Maintains technical liaison and coordination with DP and NE.

*3. Office of Safety and Quality*

Provides safety and quality certification data.

Implements safety and quality assurance criteria.

Develops quality assurance (QA) strategy and program.

Develops reliability, availability, maintainability and inspectability program.

Develops and implements a strategy for interacting with appropriate safety oversight and advisory organizations.

*4. Office of Environment*

Assures environmental protection and quality.

Develops NEPA compliance strategy.

Prepares NEPA documentation.

Develops strategy for interacting with appropriate environmental authorities and organizations.

*5. Office of Congressional and Intergovernmental Relations*

Develops and implements a plan for interacting with and informing interested Members of Congress and congressional staffs on the status of the New Production Reactor Program.

Prepares and/or coordinates congressional testimony, questions and answers and other informational work products within the NPR program.

In consultation with the cognizant operations offices, works closely with State and local authorities, as appropriate, on safety, environmental, siting, construction and other institutional matters.

Conducts a public affairs program.

*6. Office of Business Management*

Develops program and project planning strategy and reporting documentation.

Formulates, justifies and executes the budget for the NPR Program.

Performs program control activities, including schedules, milestones and cost/schedule control systems criteria.

Develops and executes a program acquisition strategy.

Provides administrative support, including office space, Automated Office Support Systems, records management, telecommunications, information management and equipment.

Provides personnel support and develops manpower allocation and utilization plans.

Coordinates with OMB and DOD on programmatic status and issues affecting the program.

NPR PROGRAM MANAGEMENT

Senator EXON. How will DOE ensure that the NPR program is not subject to problems that have arisen in other construction projects?

Mr. SALGADO. DOE has reviewed histories of large, long-time-span projects. This review encompassed privately funded reactor projects and other large federally funded projects. It was found that the primary causes of schedule delay or cost increases were: Inadequately defined scope; First-of-a-kind project; Regulatory change during project execution; Management or designer inexperience in the technology area; Labor problems; and Cash flow.

DOE has evaluated the NPR to determine the potential for impact by these factors, and is taking steps to minimize their effect. Actions taken and planned include:

*1. Top level management attention.* The NPR program manager will report directly to the chief operating officer and keep him fully informed of project, physical progress, cost performance, potential problems and actions being taken to avoid or correct the problem.

*2. Management experience.* DOE is locating some of its most experienced managers to staff the ONPR. The use of personnel with major construction project experience will help enable us to avoid pitfalls of earlier projects.

DOE plans to utilize commercial nuclear industry expertise in reactor plant design and construction, along with the National Laboratories to advise on technology features of the project. The contractor team hired to execute project design and construction will include construction management organizations experienced in reactor project execution; architect-engineering firms and quality assurance organizations with similar experience, and competent reactor manufacturers. One of the construction manager's prime responsibilities will be in the areas of cost and schedule control, constructibility of designs, value engineering, and subcontractor selection and control. Contractor team experience will be a prime factor in selection.

*3. Scope, schedule and estimate development.* Current estimates and schedules are largely based upon proponent input to ERAB which, in the case of the HWR, are an outgrowth of preconceptual design studies completed in 1985. Risk analysis has been performed on both the HWR and MHTGR proponent submittals to determine contingency factors which have been applied to current estimates. To further define scope and refine estimates and schedules, conceptual designs will be developed on both NPR projects, with estimates and schedules based upon these designs. Upon completion of Title I preliminary design, estimates and schedules will be further refined and risk analysis performed to establish reasonable contingency allowances.

*4. First-of-a-kind project.* The HWR technology is considered well proven although the specific plant design will be new. Several HTGRs have been constructed as

power producers, however, some design changes will be needed to use this technology to produce tritium or plutonium. An R&D program is presently planned for further target and reactor development. In addition, for the modular HTGR our current plans call for initial construction to be limited to only one reactor module of the planned four with construction of the remaining modules and supporting fuel/target fabrication and processing facilities deferred until after successful startup testing and a reactor performance and reliability test period for the first module.

*5. Regulatory change.* Regulatory change comes about primarily from the development of new safety criteria based upon experience and external review. Extensive standards, guides, and technical evaluation requirements have been developed over past years which will define current regulatory practices. The major concern with regulatory change with respect to costs and schedule is that it will occur after project design is well developed, requiring extensive, time consuming and costly redesign, or worse when construction is at its peak, requiring major rework. To minimize the potential impact of such change, DOE plans to assure that both the HWR and MHTGR have robust designs with ample demonstrated safety margins. This should enable the reactors to be built and operated in an environment of continual change in safety requirements.

*6. Labor problems.* Historically, these have occurred primarily in three areas: shortage of trained personnel; unrest due to wage or working condition dissatisfaction resulting in low productivity, strikes, or high turnover; and extended project span resulting in high turnover.

The first of these will be substantially offset by requiring the project contractor to provide adequate training programs, and by paying a fair wage. To minimize the third, initiatives such as establishing incentives based upon longevity will be considered.

*7. Cash flow.* The provision of the required baseline funding is largely within the control of the Congress. To provide the Congress with the best possible information, project financial controls will include specific requirements for projecting and reporting costs and physical performance.

The mission of the Office of New Production Reactors is to manage and direct a program for the acquisition and construction of new production reactor capacity to meet national security requirements. It provides for the planning and development of a program strategy and management plan which considers safety, quality, environmental and performance matters in the design and construction of new production reactor capacity.

### SEISMIC ISSUES

Senator EXON. Concern has been expressed about the ability of the NPR to withstand a major earthquake. Over 100 years ago, a major earthquake occurred about 100 miles from the Savannah River Plant. Only 5 years ago, in 1983, a major earthquake—measuring 7.3 on the Richter scale—occurred only 50 miles from the Idaho National Engineering Lab, the site of the second NPR. What steps is DOE taking to ensure that new reactors are able to withstand major earthquakes or other seismic events?

Mr. SALGADO. Over the past 10 years or so there has been an increased emphasis in both characterizing seismic hazards and the ability to design facilities for higher earthquake forces. DOE intends to take advantage of this new knowledge to incorporate technical advances in site characterization and design requirements which can be utilized to provide a level of earthquake resistance necessary to assure facility integrity. The reactors can and will be designed from a safety standpoint such that a safe and controlled shutdown will be assured. Continued operation of a reactor after sustaining a design basis earthquake would be contingent upon safety inspections, reviews and reanalyses where necessary.

### ACQUISITION SCHEDULE

Senator EXON. What is the timetable for acquisition of the new production reactors? Do you have a schedule for construction of both the heavy water reactor and the high temperature gas reactor? At what point in this schedule is the construction of a heavy water reactor at Savannah River irreversible, if, for example, a decision were made at some later point to locate the high temperature gas reactor at SRP?

Mr. SALGADO. Tentative schedules have been developed for both the NPR HWR and the NPR MHTGR. These are based upon information provided to the ERAB, DOE evaluation of the extent and nature of the R&D effort required, and the need for assurance of the initial MHTGR reactor modules performance and reliability. They indicate the NPR HWR can be accomplished within approximately 10 years.

While the first reactor module for the NPR MHTGR can be completed within approximately the same time it will require a total of approximately 15 years for completion of the remaining three reactor modules and supporting facilities.

Additional schedule information is to be provided with responses to the project request for proposals including the potential for accomplishing the HWR in a shorter timeframe. More definitive schedules and estimates will be available upon completion of the preliminary design (Title I).

If a decision were made to locate an HTGR at Savannah River, the timing of such a decision could have significant impact on costs and schedule. For example, should a decision be made to build an HTGR at SR within the next year, the effort expended upon the EIS and HWR R&D, costing in the range of $20 million, would be essentially lost with the schedule slippage dependent upon the timing of the decision. If the decision is made within 2 years, considerable HWR design effort, costing in the neighborhood of $40 million, would also have to be discarded with approximately 1 to 2 years' schedule slippage.

If a decision to change were made even later, after the start of the Title I design and commitments for long-lead procurements the cost penalty could be several hundred million dollars.

With each succeeding year, at least equivalent schedule loss would occur and financial impact would accelerate due to the extent of contractual obligations.

Moreover, the later such a decision might occur, the more detrimental it would be to our ability to produce the tritium necessary for national security. Our strategy is focused on assuring that the siting and design programs for the HWR and MHTGR minimize the risks of problems or delays to enable tritium to be produced on an urgent schedule.

### SAFETY OBJECTIVES

Senator EXON. In reviewing the NPR, the recently created Advisory Committee on Nuclear Facility Safety found that the NPR safety criteria thus far provided by DOE "are not sufficiently precise." The committee stressed that ambiguous criteria "can have a significant impact upon cost and schedule." In his response, Secretary Herrington stated that he shares the concern for a clear explanation of the criteria and indicated that a revised version of the proposed policy on safety objectives is nearing completion.

What is the status of [the] policy on safety objectives. If it is not yet complete, when do you expect to have it finalized in a manner you can submit to Congress?

Mr. SALGADO. The draft policy statement on the Department of Energy (DOE) Safety Objectives is at the final stages of internal DOE review, with a formal review ongoing by the Advisory Committee on Nuclear Facility Safety (ACNFS). This latter review, which was requested by the Secretary, has included briefings of the ACNFS and a formal response is expected shortly. Final clearance of this draft policy for issuance is awaiting the ACNFS advice to the Secretary.

It should also be noted that as part of the development of the technical requirements document, the design safety requirements are being developed for each NPR concept and these requirements will be a fundamental part of the DOE NPR acquisition process.

### ROLE OF INSTITUTE FOR NUCLEAR POWER OPERATIONS

Senator EXON. Can you explain the role of INPO in DOE's reactor operations and how it could be usefully utilized for construction and operation of the NPR?

Mr. SALGADO. The existing cooperative agreement with the Institute of Nuclear Power Operations (INPO) includes participation by the DOE production reactor management and operating contractors. This participation includes the sharing of construction and operating experience and data with the commercial industry, participation in training and accreditation related activities, attendance at INPO sponsored workshops and seminars in areas such as maintenance, emergency preparedness, configuration management, operating experience reviews, chemistry, technical support, outage management and other topical areas, and exchange and personnel. We would intend that the NPR would be included in all of these cooperative activities.

INPO has also developed guidelines for nuclear power station construction projects and criteria for construction project evaluations and good practices in several important construction related areas such as installation of electric cable, expansion anchors in concrete, control of welding material, large-bore piping fit-up, and configuration management. These INPO guidelines and practices would be used by the Department in conjunction with other comprehensive assessments of lessons

learned from large nuclear projects to ensure that the best practices of the industry were utilized during the construction of the NPR.

COST COMPARISONS

Senator EXON. The average final cost of commercial nuclear reactors which have come on line from January 1980 through December 1986 was 8 times greater than the initial cost estimates on which the reactors were based. Were prior underestimates of commercial reactor construction considered in putting together the cost estimates for NPR? What, if any, historical data from prior DOE construction projects was used in constructing the cost data for NPR? Please provide for the record a review of the initial and final costs of all DOE construction projects over $100 million initiated within the last 10 years.

Mr. SALGADO. Underestimates in previous commercial power plants were considered in developing the cost estimates for the NPR. However, a direct comparison between recently completed commercially funded power reactors and the government-funded proposed NPR cannot be made. Many commercial plants were delayed because of slippage in the growth of demand for new generating capacity brought on by the recession of the late 1970s and because of regulatory backfits required after the Three Mile Island accident. The NPR design approach will be to achieve approximately 70 percent design completion before major construction begins. This along with a continuous safety certification process should enable the problems encountered by some of the commercial plants to be significantly mitigated.

In preparing their cost estimates, the NPR vendor/proponents included the latest versions of safety and environmental related equipment. The Cost Evaluation Technical Support Group (CETSG) also included compensation for possible underestimation in the contingency factor applied to each project. These factors were based on probabilistic cost/risk analysis and the results of a RAND Corp. cost growth study (The Megaprojects Study) which included several commercial reactors in its data base. In addition, the CETSG adjusted capital cost estimates compare favorably with estimates derived by an internal DOE Defense Programs independent cost estimate which utilized the Energy Economic Data Base maintained by United Engineers and Oak Ridge National Laboratory.

Regarding comparisons with the commercial nuclear industry, it must be noted that commercial reactor project costs include a very large proportion of interest costs (interest during construction) in their final costs. What was initially estimated to take 5–8 years to construct has instead taken 10 to 15 years, including periods of extremely high interest rates. The associated interest costs for these delays were large and in some cases were equal to or greater than the initial projected costs. The delays were mainly the result of intervention, backfitting of new equipment to meet post-Three Mile Island safety standards mandated by the NRC, and time-consuming resolution of quality assurance problems discovered after-the-fact. The initial commercial reactor cost estimates did not include the costs of retrofitting and in some cases rebuilding parts of the reactor to meet newer quality and safety standards. The NPR cost estimate assumes that the construction task will be completed on schedule, the QA and safety matters will be handled and resolved prior to construction, and that the design scope of the project will remain the same over the lifetime of the project.

There is no recent cost data on DOE-constructed reactors available since no large reactors have been completed in the last few years. However, for the NPR support facilities, which are mainly chemical and metallurgical facilities, there is data based on recent upgrades to the weapons complex which were made to meet more stringent environmental standards. Such recent data was taken into account by the vendors and by the CETSG in estimating the support facility costs.

In summary, the estimates provided in the NPR capacity cost evaluation included the following assumptions:

1. The scope of the project remains the same (no major redesign); 2. The R&D, design, and construction schedules are met; 3. That an expeditious safety review process is achieved; 4. The NPR project meets current and reasonably projected environmental and safety standards; and 5. The estimates were prepared using January 1988 constant dollars as well as using a real discount rate of 4 percent. No interest during construction is added.

DOE produces annually a report on the status of all construction projects with a cost of $100 million or greater, as requested in House Report 99–195 on the fiscal year 1986 Energy and Water Appropriations bill. This report is provided to both the House and Senate Appropriations Committees. A copy of the latest report (May 3, 1988) is attached. An analysis of the report was performed to summarize the status

and performance of the projects. The excerpted results are shown in the attached table.

[The report referred to appears on page 58 of the hearing record.]

LIGHT WATER REACTOR TARGET DEVELOPMENT

Senator EXON. Why are you proposing to spend money on light water target development?

Mr. SALGADO. Although the HWR and the MHTGR technologies have been selected as preferred alternatives for analysis as part of the NEPA process, no final decisions have been made. Both the HWR and MHTGR technologies require some degree of design development, and both must proceed through a safety certification process. It is possible for problems to develop with either concept. Therefore, it is prudent to maintain the LWR technology as a contingency for new production reactor capacity, and modest development is appropriate. In addition, to support the NEPA process, work must continue on LWR target development to avoid a de facto decision to drop prematurely the LWR technology as a reasonable alternative under NEPA.

Senator EXON. Why was the value of the heavy water moderator needed for the HWR not included in the cost estimate for the HWR when the cost of the helium for the MHTGR was included in the cost estimates for that concept?

Mr. SALGADO. Due to the shutdown of C reactor at Savannah River, and the reserves of heavy water that DOE has maintained, we find that we already have a quantity of heavy water sufficient to supply two MPR HWRs. During the time that the NPR operates, heavy water sufficient for five HWRs could be available. Thus, no new appropriations would be required for the heavy water for the new HWR NPR. The helium for the MHTGR, on the other hand, would have to be purchased. For these reasons, we felt it proper to include the cost of the helium coolant for the MHTGR, but to exclude the cost of the available heavy water for the HWR.

Senator EXON. What is the probability that additional sources of tritium will be required prior to the time an NPR can begin operating due to the impact of the aging Savannah River reactors? What options are available to address this problem should it arise?

Mr. SALGADO. DOE believes that ongoing and continuing safety improvements to the SRP reactors will be adequate to permit restart and operations to meet tritium demand through the period prior to an NPR startup. However, if restart delays persist or the reactors are not able to operate at sufficient power levels to produce the required quantities there could be a significant impact on the nuclear weapons capability of the Nation. Because of the potential for this unacceptable situation DOE has investigated tritium availability from alternate sources. The only realistic tritium contingency option available is to restart the N reactor for tritium production but tritium product would not be available for several years. Therefore, DOE plans to resolve the safety and operational issues at the Savannah River Plant to allow the safe restart of the production reactors as quickly as possible.

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QUESTIONS SUBMITTED BY SENATOR KENNEDY

Senator KENNEDY. In your testimony, you indicated that DOE "is proceeding on an urgent schedule with construction of a heavy water reactor at Savannah River designed to produce 100 percent of expected tritium requirements."

(a) Please provide a detailed description of the force planning assumptions (e.g., numbers and types of warheads) that have been employed to define the current "goal quantity" for tritium production referred to in your testimony.

(b) Please provide a detailed breakdown of the NPR goal quantity for tritium according to the type of warhead/bomb assumed to be in the future stockpile. Please distinguish between initial fill and periodic replenishment requirements for each weapon type.

Mr. SALGADO. [Deleted.]

Senator KENNEDY. (a) For the unclassified record, please state the aggregate percentage reduction in the goal quantity (year 2000) tritium requirement if this requirement is constrained to maintaining only the 6,000 missile warhead force structure agreed upon at the Moscow summit, and this force structure is composed of warhead designs that have been authorized for entry into the production engineering stage in fiscal year 1989 or prior years.

(b) For the unclassified record, what would be the overall percentage reduction from the current expected tritium requirement if one assumes adding [to the force

in (a) above] 3,000 bomber-carried weapons (SRAMS and gravity bombs) for a total START strategic stockpile of 9,000 warheads.

Mr. SALGADO. [Deleted.]

Senator KENNEDY. For the unclassified record, please provide the percentage of the overall NPR goal quantity for tritium that is accounted for by the broad category of non-strategic nuclear warheads and bombs.

Mr. SALGADO. [Deleted.]

Senator KENNEDY. What is the earliest practical date for bringing the NPR on line at Savannah River?

Mr. SALGADO. Current schedules indicate the NPR at SRP can be brought on line within 10 years of design start, which is estimated to begin in August/September, 1989. Information developed during the ERAB evaluation indicates this potentially could be improved to a timeframe of about 7 or 8 years. The project request for proposals now being prepared includes a requirement for responders to provide schedules for both 10- and 7-year timeframes together with information as to actions required by the Government for the shorter schedule.

Senator KENNEDY. How does the Department of Energy plan to meet goal quantities for tritium in the period from now until the NPR can be made operational?

Mr. SALGADO. The Department of Energy plans on meeting tritium requirements in the period from now until the NPR can be made operational by restarting and operating the K, P, and L reactors at the Savannah River Plant in South Carolina.

Senator KENNEDY. Please describe the contingency plans for obtaining adequate supplies of tritium in the event the Savannah River reactors are forced to shut down for an extended period.

Mr. SALGADO. The tritium contingency options available are dependent on how long the Savannah River Plant reactors would operate before they are forced to shut down for an extended period. Operating the reactors at a power level above current restrictions could provide a surge capability which would be available for use. The major alternate source being investigated is the restart of N reactor (Hanford, WA) for tritium production.

Senator KENNEDY. How long an interruption in tritium production can be tolerated before delays are experienced in the maintenance operations for the deployed stockpile?

Mr. SALGADO. A precise answer to this question is not available. In addressing the current situation, if one or more Savannah River reactors is not operating at the desired power level by the summer of 1989, deliveries from Savannah River are likely to be missed or delayed. This may or may not have an impact on the deployed stockpile. The Department of Energy is examining its handling of tritium throughout the nuclear weapons complex to determine if there are any changes which could be made to current operations and schedules which might result in a one-time reduction in tritium demand. It may also be necessary to discuss with the Department of Defense (DOD) changes to the scheduling of turn-in and delivery of replenishment components. These steps, if taken, will tend to increase the risks of not being able to provide complete stockpile support over the long term. Only after the analyses, examinations, and discussions with DOD can the absolute maximum tolerable interruption be determined.

Senator KENNEDY. What is the size of the tritium reserve stockpile, and how long will it last?

Mr. SALGADO. Any discussion of tritium stockpile specifics would be classified. However, there is an operational pipeline inventory which permits efficient and effective operation of the tritium facilities for processing tritium in support of national defense needs. This pipeline inventory is currently at the level believed necessary to efficiently operate the tritium facilities. However, due to the current shutdown of the SPR reactors for safety upgrades, seismic evaluation and routine maintenance, this operational pipeline inventory will soon be reduced to minimum inventory levels where the potential for operational impacts is very high. If the SPR reactors are forced to continue to operate at or near 50 percent power levels after restart we will remain highly vulnerable to supply disruptions until a new production reactor becomes available.

Senator KENNEDY. Please provide a diagram or table which shows the empirical relationship between delayed tritium and degraded weapon yields.

How long a delay can be tolerated before significant numbers of boosted primaries will fail to ignite weapon secondaries?

Mr. SALGADO. Each nuclear warhead design would react differently to having its tritium replenishment delayed. There are variations in how well warheads tolerate delays in replenishment without significant reduction in effectiveness or reliability.

In many cases there is insufficient data from underground nuclear testing to make an adequate determination of the effects of delaying tritium replenishment.

The nuclear design laboratories are currently assessing the effects of tritium replenishment delays. Detailed answers to the questions, as well as can be supported by scientific data, will be available after this assessment.

Senator KENNEDY. Which low priority weapons in the stockpile could be retired early and used as a source of tritium for higher priority warheads?

Mr. SALGADO. The Department of Energy cannot and should not establish priorities among weapon systems. This question has been forwarded to the Department of Defense for consideration.

Senator KENNEDY. How much is the Department of Energy planning to spend to upgrade the Savannah River reactors (P, L, K) to meet goal quantities for tritium until the new production reactor can be brought on line? Please describe the nature of these improvements, and any revisions to current plans that may be prompted by the recent revelations of hidden safety problems at the SPR reactors.

Mr. SALGADO. The Department has an ongoing reactor maintenance and upgrade program at Savannah River. Based on a series of intensive reviews, DOE is spending additional funding for activities such as seismic bracing, fire protection, reactor isotope release monitoring, improved reactor spray systems, etc. Incremental funding of approximately $230 million will be expended from fiscal year 1987 to fiscal year 1989 on these activities.

Based on the current problems associated with the reactors at Savannah River, including acceleration of contractor transition, there will be additional costs in fiscal year 1989 and beyond. These costs are currently being evaluated. Activities which are under consideration include: expansion and upgrade to reactor staffs, reactor monitoring and evaluation, outside independent technical reviews, additional seismic modification, additional offsite and onsite technical support services, contractor transition costs, additional Federal manpower, and acceleration of construction of a cooling tower for K reactor.

Attached is a table showing projects which have been proposed for future funding at Savannah River prior to the operation of a new production reactor. A reactor safety improvement program is being implemented which will provide an integrated system for ranking and monitoring disposition of short-term and long-term safety upgrades.

*Projected reactor projects* [1]

[Dollars in millions]

| | *Costs* |
|---|---|
| Seismic upgrades | [1] 30 |
| Reactor isotope release monitor system (per reactor) | 37 |
| Emergency diesel generation reliability | [1] 12 |
| Extended diesel engine operation | [1] 35 |
| Plantwide fire protection, phase I | 115 |
| Reactor effluent cooling water thermal mitigation [2] | [1] 130 |
| Reactor electrical distribution system [2] | 21 |
| Replace flood control pumps | [1] 45 |
| Reactor charge discharge control equipment | 5 |
| Reactor GM generators load reduction | [1] 8 |
| Piping system upgrade | 25 |
| Increased in-tank monitoring | 8 |
| Process water heat exchangers | 18 |
| Reactor tank level sensor | 5 |
| Powerhouse instrumentation replacement | 9 |
| L reactor secondary water supply | [1] 5 |
| Reactor charge/discharge training simulation | 8 |
| Replace purification area distillation column | [1] 15 |
| Install turbogenerators to P-area | [1] 12 |
| Fuel handling control and monitoring system | [1] 23 |
| Improved reactor spray system (reactor) | [1] 40 |
| Reactor fuel handling improvements | [2] 13 |
| Reactor fast shutdown | [1] 20 |

[1] Estimates only, not validated by Department.
[2] Ongoing projects.

Senator KENNEDY. Please provide a table showing the annual sums expended by DOE for facilities restoration and capital equipment at weapons materials and warhead production facilities in the period 1981–1988?

Mr. SALGADO. See attached table.

DEFENSE PROGRAMS, FACILITY RESTORATION AND CAPITAL EQUIPMENT

[Budget authority in millions]

| | Nuclear materials production | | Weapons production | | Total | | |
|---|---|---|---|---|---|---|---|
| | Equipment | Construction | Equipment | Construction | Equipment | Construction | Total |
| Fiscal year: | | | | | | | |
| 1981 | $53.1 | $135.5 | $110.4 | $99.2 | $163.5 | $234.7 | $398.2 |
| 1982 | 63.0 | 148.5 | 148.5 | 171.1 | 211.5 | 319.6 | 531.1 |
| 1983 | 107.7 | 184.7 | 175.7 | 186.5 | 283.4 | 371.2 | 654.6 |
| 1984 | 98.5 | 147.6 | 195.0 | 259.2 | 293.5 | 406.8 | 700.3 |
| 1985 | 117.7 | 112.1 | 204.2 | 277.5 | 321.9 | 389.6 | 711.5 |
| 1986 | 109.5 | 119.6 | 205.2 | 256.4 | 314.7 | 376.0 | 690.7 |
| 1987 | 107.2 | 131.1 | 242.3 | 211.3 | 349.5 | 342.4 | 691.9 |
| 1988 | 91.3 | 125.0 | 223.4 | 195.5 | 314.7 | 320.5 | 635.2 |
| Total | 748.0 | 1,104.1 | 1,504.7 | 1,656.7 | 2,252.7 | 2,760.8 | 5,013.5 |

[Thereupon, at 11:43 a.m., the subcommittee recessed subject to the call of the Chair.]

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